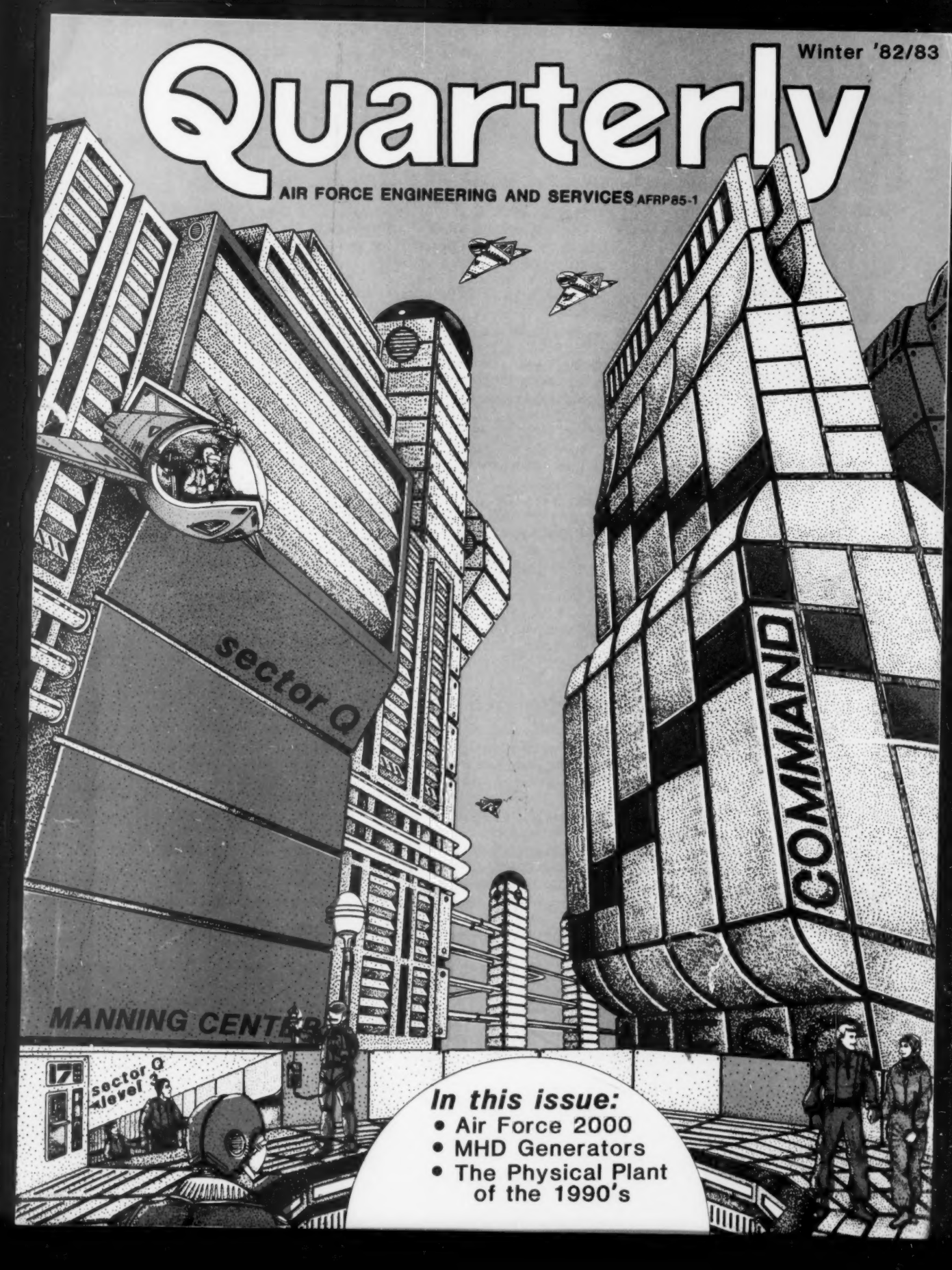
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Quarterly
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MANNING CENTER
sector Q
level 3
In this issue:
• Air Force 2000
• MHD Generators
• The Physical Plant of the 1990's

From the Director

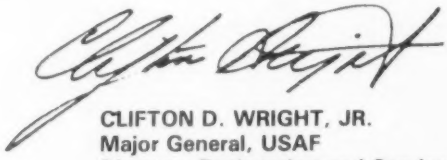
This issue of the **Quarterly** provides a timely insight into the challenges confronting the Engineering and Services Community and the entire Air Force in the year 2000 and beyond. The lead article provides an Engineering and Services perspective on the Air Force report, "Air Force 2000, Air Power Entering the 21st Century." "AF 2000" was prepared to aid Air Force leadership in looking beyond the day-to-day "battle of the in-basket" toward planning the Air Force course for the future.

This thorough and continuous long-range planning effort gives us an environment in which the very difficult and critical task of preparing for the future can be undertaken confidently. We must, therefore, make it our business to deal continuously with the uncertainties of the future instead of planning when it is convenient to do so. The very nature of our business dictates that we must excel not only in our daily activities but we must also do a good job of planning for the future. We must:

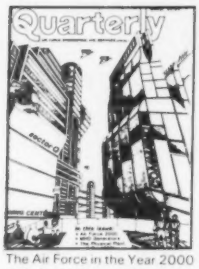
- Plan well to be prepared to support our combat forces in any contingency
- Plan methods to assist our people and improve the way we do business at base level
- Plan the recruiting, retention and development of the most important Engineering and Services resource—our people
- Chart a course for modernization of Air Force facilities through better development and execution of our program
- Re-emphasize our energy programs and plan new energy initiatives for the future.

Planning is not an option—it is an absolute requirement. A good plan helps us identify limitations, deficiencies and issues for management attention. Our planning has already begun. We are well on the way to highlighting our key goals and objectives in an Engineering and Services Strategic Plan. We are looking at near-term as well as long-term strategies which will guide us toward achieving our goals and objectives and which I believe will ultimately serve as a roadmap for the Engineering and Services community. Our Strategic Plan will be a living document, not only to provide guidance, but to allow an unceasing examination of new goals and objectives to guide us toward the year 2000.

I solicit the support of each you as we develop the Strategic Plan and as we work together to achieve our Engineering and Services goals and objectives.



CLIFTON D. WRIGHT, JR.
Major General, USAF
Director, Engineering and Services



The Air Force in the Year 2000 and beyond — challenging Engineering and Services professionals to sustain our dynamic role in the defense of the nation, while planning and programming a renewed Air Force.

engineering & services

Air Force
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AIR FORCE 2000

by Capt. Dean Fox

The Air Force 2000 study was initiated for the purpose of making a realistic assessment of the challenges likely to confront the Air Force at the turn of the century. AF 2000 takes a broad view of economic, demographic, global and technological matters to provide a comprehensive picture of the operational environment in which the Air Force of the future will carry out its missions. AF/XOXIP (DCS Plans and Operations, Long Range Plans Division) was chartered to develop the AF 2000 study with assistance from a multifunctional Air Staff panel (including AF/LEE representation).

The team utilized input from the Air Staff, MAJCOMs, Special Operating Agencies, and key DOD and Air Force general officers and officials, reflecting the corporate vision of our senior leadership.

The Air Force 2000 study should be viewed as the first step in a continuing effort to investigate essential issues and trends influencing the political-economic military environment.

The first three chapters represent an attempt to come to grips with the environment that will necessarily determine air power requirements, strategic components, force characteristics, and employment concepts for the future. The remaining six chapters and appendices are derived from the environmental, strategic, and conceptual framework. Probably the most dominant theme throughout this study is the imperative that the Air Force of the 21st Century be a flexible warfighting force. Flexibility must be emphasized in planning, organization, training, force employment, R&D, weapon systems decisions, and personnel considerations to meet the uncertain challenges of the 21st century.

Air Force Strategy and the Global Environment

The world of 2000 will present startling new challenges for the Air Force and Engineering and Services. Nations will experience both rapid technological advancements and continuing problems with resource availability. Advances in computer systems, microelectronics, signal processing, communications, directed energy technology, and composite materials will enhance the economies and military forces of major industrial nations. Against these gifts of modern technology, the unresolved problems of overpopulation, food scarcity, inequitable wealth distribution, energy shortages, and struggles over natural resources, as well as many other critical problems, will stand out in stark contrast (Figure 1).

The gap between the economic status of the "have" nations and that of the "have not" Third World nations will persist and probably expand in absolute terms. This is very likely to provide fertile ground for future conflict among nations.

Global Issues

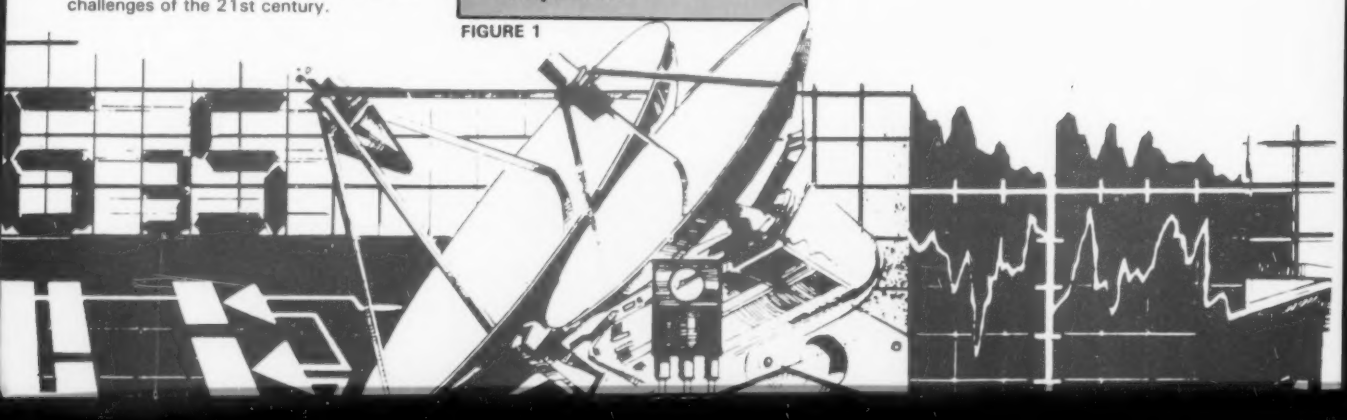
- Soviet Threat
- Terrorism
- Alliances
- Nuclear Proliferaton
- Petroleum
- Space
- Mineral Resources
- Foreign Arms Trade
- Population

FIGURE 1

As we enter the next century, national power will continue to involve command over resources and the risk of war will be ever present. International competition will be more complex and intense, because the environment of the future will feature a number of new major powers, some new regional powers, and an assortment of minor powers within the Third World. Whatever these powers do—economically, politically, or militarily—will command the immediate attention of the superpowers.

Whether in low-level, theater or global confrontation, the Air Force must be prepared and must have the essential Engineering and Services support to enable us to deter war. If deterrence fails, it must be able to "Fly, Fight, and Win."

We must be prepared to wage war across the spectrum of low-level, theater, and strategic conflict. Low-level conflict



ranges from political unrest to small-scale regional conflict. The responsibility for deterring and defeating organized terrorism or insurgency will rest heavily on the nations involved. Our current strategy of coalition-building, combined with a tailored, rapid-response capability is well suited for the year 2000. Above all, the Air Force and its Engineering and Services essential support elements must remain flexible. At the theater level, resource limitations may preclude attaining a global war-fighting capability to meet and defeat simultaneous, multi-theater aggression. Alliances to successfully defeat an attack on one theater while deterring or delaying enemy attacks elsewhere will be necessary. We will need to continue emphasis on defeating Soviet theater attacks with a combination of forward-deployed and CONUS-reinforcement forces. By improving standoff weapons, all-weather weapons, specialized munitions, and real-time target location means, technology will magnify the destruction air power can deliver on enemy forces. We must fully develop the ability to continue operations in a chemical/nuclear-contaminated environment and to retaliate in time.

Strategic offensive forces are likely to persist as the dominant element of U.S. nuclear strategy through 2000. We will require diversification of delivery systems and continued improvements in survivability, sustainability, endurability, and penetration. While significant mutual reductions in strategic offensive forces or a freeze on new deployments could cause a major strategy change, this is unlikely. In the future, however, the outcome of arms control negotiations might be efforts to increase the survivability of offensive forces by a deployment of defensive systems. A major shift in strategy could also result from deployment of an effective, reliable space or land-based strategic defense system. The Air Force's air and space resources will continue to be the most effective means to conduct prompt and sustained operations. Whether it be for combat, airlift, communications, navigation, reconnaissance, or intelligence operations, air power is the dimension that provides the greatest flexibility and, therefore, a vital opportunity to increase U.S. military effectiveness.

Air Warfare Concepts

To meet the challenges throughout the conflict spectrum (Figure 2), posed by an increasingly contentious and well-armed world, we need war-fighting concepts that capitalize on the contribution that air power can make to the security of the nation.

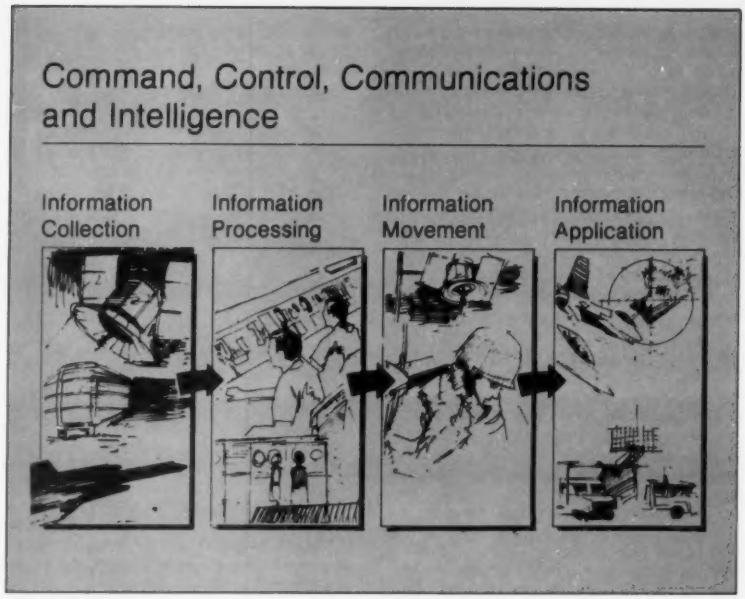


FIGURE 3

Low-level conflict, which spans the political-military spectrum from nonviolent political unrest to intense civil war, will continue to threaten U.S. interests.

The Air Force needs to enhance education and training in this area—reexamine basic doctrine and organizational structure, redefine the goals of security assistance efforts, and improve intelligence collection capabilities. More planning and exercising of special operations forces should be done in concert with mainstream forces.

The second conflict possibility is theater warfare, which includes war-fighting operations in a conventional, chemical, or nuclear environment within a limited geographic area. To prevail in theater conflict, we must seize the initiative and quickly achieve both air and space superiority. Air superiority will require the capability to effectively attack and neutralize enemy airfields, destroy aircraft before they can employ their weapons, and destroy surface-to-air defenses. Space superiority is required to ensure that our space-based assets are available to support theater forces.

The Air Force must also be able to generate large numbers of effective sorties. Therefore, we should develop:

- Highly reliable and supportable aircraft with the capability to operate from damaged runways
- The capability to operate in a high-intensity conventional, chemical, or nuclear environment; and
- Airlift and air refueling assets that are balanced with the fighting forces.

Bombers can provide extended maritime support as well as deliver conventional firepower on land. We should strive for a bomber force of sufficient size and flexibility to provide for the theater support role.

The third area of conflict spectrum is strategic nuclear conflict which can be divided into three categories: limited, massive, and prolonged exchanges. An important objective in limited nuclear conflict is to control escalation. To do this, the U.S. must be able to communicate with the appropriate enemy leadership and must be able to execute a range of strike options while limiting collateral damage. In a massive exchange scenario, the objective is to survive and retaliate so as to deny the agressor any gain by initiating the attack. The enemy must be denied the ability to conduct effective war-fighting operations. To fight in this environment, the Air Force needs a mix of forces that can survive and have the flexibility to strike a variety of fixed and mobile targets. Penetrating bombers and cruise missiles and survivable and enduring intercontinental ballistic missiles (ICBMs) are all needed to ensure flexibility and to hold Soviet political, economic, and military systems at risks during any phase of nuclear conflict.

C3I and Air Force Technology

Air Force success in air warfare in the

CONFLICT SPECTRUM

Lower Level Conflict	Theater Conflict	Strategic Conflict
• Political Unrest	• Theater Conventional	• Limited Strategic Conflict
• Organized Terrorism	• Simultaneous Attacks in Multiple Theaters	• Central Nuclear War
• Insurgency/Civil War	• Theater Nuclear Conflict	

FIGURE 2

year 2000 will depend, for the most part, on the operation of an integrated command, control, communications, and intelligence (C3I) system. This system will combine the functions of collecting, processing, transmitting, and applying essential information to manage and execute Air Force operations effectively (Figure 3). This essential information includes details about the enemy and friendly forces, logistics, weather and personnel data. Any future conflict in which the United States is involved will require the use of information management. The ability to have accurate, timely, and appropriate information and to transmit timely and decisive orders is essential to the contribution air power makes to the winning of wars.

The goal of Air Force technology and of the Technology Base is to maintain technological superiority over potental adversaries and protect the United States from adverse technological surprise. To achieve these goals, we must have an integrated, focused program to encourage and foster new concepts and techniques that could have significant impact on the conduct of military missions. The Technology Base clearly plays a vital role in the research and development process and its continued support is essential. In spite of determined efforts to strengthen the Technology Base investment, only modest real growth has been seen. In real purchasing power, investment in the Technology Base is now about 60 percent of its level in the mid 1960's. We must establish a more aggressive real growth trend now to adequately address high-payoff technologies.

Manpower, Personnel and Training

The principal challenges facing the Air Force and Engineering and Services in manpower, personnel and training through the year 2000 focus on instilling and perpetuating a war-fighting spirit and perspective among our people. The ability to rekindle that innate spirit to fight and win will depend largely on Air Force leadership, whose challenge it will be to create an environment that builds the institutional values—loyalty, unit cohesion, esprit, and sense of purpose and dedication to the mission—that have so often in history spelled the difference between victory and defeat. In the context of the overriding importance of the war-fighting spirit, of strong and dynamic leadership, and of the perpetuation of institutional values, Air Force and Engineering and Services has the need for high quality people; the changing requirements for people due to new and evolving technology and missions; and the dynamic social, economic, and demographic factors that will influence the availability of people in the future. There are seven key manpower, personnel, and training issues that will shape the Air Force and Engineering and Services through the end of this century. These issues are:

- War-Fighting Perspective (the vital need to keep the orientation of our people on the mission)

- Leadership and Military Values (the presence of leadership as the cornerstone of military effectiveness)
- Compensation (the single factor that pervades all other issues and ultimately determines the ability to attract, motivate, and retain Air Force people)
- Manpower Requirements (the need to be able to develop the optimum mix of people)
- Training (changes necessitated by increasing technologically sophisticated hardware)
- Retention (keeping experienced and trained people in the Air Force).

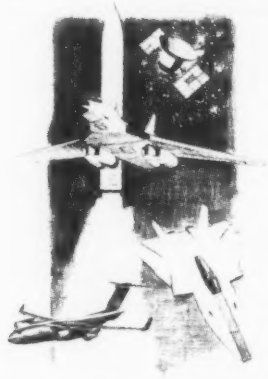
Financial Planning

Air Force and Engineering and Services funding in the future will continue to be constrained by the U.S. economic and budgetary environment. The U.S. economy will experience 2.6 to 2.8 percent average annual real growth through 2000, as opposed to the 3.3 percent enjoyed over the past 25 years. An even more important determinant of future defense funding levels is the budgetary and political-economic environment. The perception of the external threat drives allocation decision, but that perception is also influenced by domestic considerations and by precedents set by past levels of defense spending. Past patterns of DOD and Air Force funding provide indications of the reasonableness of future financial planning. Since 1950, funding has only peaked during wars and strategic build-ups; there has been no long-term growth trend. Moreover, growth cycles have not exceeded three years. Despite the unprecedented peacetime funding growth for the period 1979-82, the Program Objective Memorandum (POM) planning for continued substantial increases in almost all appropriations and major force programs has reflected optimism unsubstantiated by either an analysis of the economic and budgetary environment or historical funding patterns. We must develop a financial strategy to get to 2000 to resolve the dilemma of requirements that exceed fiscal resources.

The Engineering and Services Perspective

"When I speak of air strength, I am not speaking only of airplanes. I am speaking of airfields, fuel supplies, depots, stockpiles of aircraft parts, weapons and weapons stockpiles, control and communication centers, highly trained and skilled manpower—and airplanes. These constitute airpower." Gen. Curtis LeMay, USAF (Ret.)

Engineering and Services in the year 2000 and beyond will continue to be a primary contributor to airpower, through our role in providing facilities, services and air base survivability and recovery measures. Our support requirements have evolved from the designs and employment concepts of the weapon systems being supported, and these designs have created manpower—and equipment-intensive support processes. The resultant fixed-site air base and industrialized support structure is highly vulnerable to combat disruption or destruction. The Weapons Systems Support Concept for 2000 and beyond emphasizes the integraton of weapon system design, weapon system employment and 21st Century logistics and engineering support. Weapon system reliability, maintainability, and suitability will be significantly improved through technological advances. Enhanced supportability will increase the productivity of mission-capable weapon systems, provide



expanded war-fighting options, and permit streamlined maintenance processes. These streamlined weapon system support processes, in lean combat configurations focused on flightline sortie production, will provide the much-needed capabilities necessary for decentralized, small-unit autonomy of operations. Our Engineering and Services support strategy for the year 2000 and beyond, then, must focus on reducing support structure vulnerability by emphasizing mobility, flexibility and survivability to sustain decentralized operations. Without survivable support processes, support resources, and support structures, war-fighting forces cannot be sustained in combat.

Our air bases are the physical plants from which air operations are conducted. As "platforms" for Air Force weapon

systems, air bases will continue to be necessary in the 21st Century for support of combat forces. In an environment of change and competing priorities, our major Engineering and Services challenges for the year 2000 are:

- Meeting air base requirements for bed-down of new weapon systems
- Supporting global force projection strategies through construction abroad
- Executing costly measures to ensure the survivability of existing air base facilities
- Upgrading a rapidly aging physical plant
- Developing ways to reduce the vunnerability of a fixed-state air base structure

Two significant characteristics of our air bases are size and age. Currently valued at a replacement cost of $95.6 billion, the physical plant that Engineering and Services supports includes 134 major installations (down from 238 in 1962, a 44 per-

cent reduction). Although the number of major installations has been reduced, the constant dollar-cost of operations and maintenance continues to rise, largely due to the operating inefficiencies of age. Constraints in funding, as well as the nature of funding processes, inhibit our ability to simultaneously upgrade the aging physical plant and sustain the air base needs of changing Air Force missions. These competing demands will force difficult decisions for Engineering and Services and the Air Force through the remainder of this century.

Military forces reflect their capabilities and employment strategies through their basing structures. Our existing air base structure reflects the intent to fight from a limited number of vulnerable weapon system platforms, which in turn are dependent on relatively larger and even more vulnerable support structures. Dependence on these fixed-site air base structures may be a limiting factor for the most effective employment of 21st Century air power. The enemy's growing capabilities in theater conventional warfare, and the increasing number and accuracy of both theater and strategic nuclear warheads, make a limited number of fixed-site war-fighting platforms vulnerable to disruption or destruction. To operate effectively in a dynamic 21st Century warfare environment, we must have more war-fighting platforms. In the foreseeable future there is neither time nor money to realistically consider building these platforms.

We can, however, establish the needed war-fighting platforms by expanding the number of potential locations for air operations outside the existing Air Force basing structure. This can be accomplished without the need for extensive construction through dispersal to existing airfields (military and civilian; CONUS and overseas), or airfield equivalents. Sortie production will no longer be dependent on an industrialized on-site repair activity. With warfighting platforms at dispersal sites, we will be able to locate these industrialized support processes within the existing basing structure to achieve the economies of resource pooling. Streamlined weapon system support processes capable of mobility, coupled with the inherent flexibility of decentralized operations, provide the opportunity to modify a support-driven basing structure. The ability to provide combat-configured support at vast numbers of dispersed operating locations is fundamental to the support strategy for the 21st Century. Air base support functions within the existing basing structure are reallocated such that three distinctly different kinds of air bases emerge:

(1) **Dispersed Operating Locations** – war-fighting platforms for contingency and training use only, which are outside the Air Force basing structure.

(2) **Operating Bases** – existing air bases reduced to exclude on-site repair activities

with a minimum-essential support structure and

(3) **Main Support Bases** – existing air bases expanded to include primary industrial repair processes and a complete support structure.

We can establish Dispersed Operating Locations on the basis of Air Force mission needs and the suitability of available airfields to meet those mission needs. The number of locations will be limited only by the need to execute joint-use agreements in the CONUS, to negotiate host nation support of bilateral agreements overseas; and the appropriateness of the available facilities for particular weapon systems. In peacetime, Dispersed Operating Locations need not be under Air Force control, and operating units will only be assigned in wartime plans and training exercises. Where permanent party liaison activities are necessary, we will utilize Air Force civilian and reserve personnel.

Support structure requirements for Dispersed Operating Locations will be determined by operational requirements and provided by deployment or by prepositioning. Where prepositioned, support resources must be limited to minimum essentials protected by appropriate survivability measures. In most cases, we will provide all support structure requirements through rapid deployment, featuring the streamlined processes and mobility of autonomous small-unit operational support. Operations will be characterized by site austerity, lean combat configuration, and capability for decentralized autonomy.

Dispersed Operating Locations must not be limited to conventional airfields. We will use unconventional facilities to the extent that 21st Century weapon systems are capable of using them. Unconventional facilities which can provide a virtually unlimited number of potental war-fighting platforms include relatively short civilian airfields, sections of suitable roads and highways, and any other usable "platform" suitable for V-STOL operations. Engineering and Services will develop the capability to provide support at Dispersed Operating Locations for tactical and strategic forces both in the CONUS and overseas. When weapon system mobility is complemented by an equally mobile and flexible support structure, survivability in a fast-moving battlefield will be substantially enhanced. We must stress rapid relocation from a limited number of air bases to vast numbers of Dispersed Operating Locations for survival in combat. Major aircraft maintenance requirements will be shifted to Main Support Bases from Satellite Operating Locations for survival in combat. Major aircraft maintenance requirements will be shifted to Main Support Bases from Satellite Operating Bases, allowing the Satellite Operating Bases to maintain a lean support structure for air operations. Main Support Bases will no longer be our war-fighting platforms, but will support a family of Satellite Operating Bases, which in turn will provide access and staging to Dispersed Operating Locations (Figure 4).

The vulnerability of consolidated industrialized repair and heavy maintenance activities will be a major consideration. Hardening, dispersal, and redundancy must be applied to repair activities on theater Main Support Bases. With larger air base populations, opportunities to enhance quality of life will expand as resources are pooled against requirements for facilities and programs at fewer locations. We must consider the adjacent private sector as a criterion in Main Support Base selection so that full advantage can be taken of off-base community support capabilities. Because community support functons and facilities for Air Force people are essentially identical to those provided in the private sector, we should develop processes involving non-ownership options to reduce Air Force investment needs. The evolution of larger Main Support Bases could positively affect quality of life by decreasing family relocations and providing improved opportunities for joint-spouse assignments, working wives, dependent schooling, and local home-ownership. The economies of resource pooling will provide significant opportunities for improvement in plant management and design. Engineering and Services will consolidate facility requirements allowing "megastructure" concepts to evolve to meet these requirements with highly functional and efficient work-place environments enhanced by advanced survivability techniques. New design criteria will apply construction materials and techniques to reduce both first costs and life-cycle costs. We will achieve energy efficiency through extensive applications of passive/active solar and energy management systems. Advanced technologies will be applied in all functional areas to enhance productivity. Comprehensive and community planning processes will be essential as the air base affects its surrounding environment.

Conclusions

Given the great destructive power available to potential adversaries and the constant state of high readiness that must be maintained, the Engineering and Services structure of the 21st Century will have to be mobile, flexible, and survivable. Of these characteristics, survivability will be most important in the year 2000 and beyond. Without survivable support processes, support resources, and support structures, we cannot sustain war-fighting forces in combat. Operational support reflects the design characteristics of employment strategies of the weapon systems being supported. In response to national security threats, technology has been used to create sophisticated weapon systems whose complexity has produced the requirement for a manpower-and equipment-intensive support process. Our resultant support structure is now characterized by its large size, high degree of industrialization, relative immobility, and extreme vulnerability. While acceptable for peacetime, the current support structure is ill-prepared for war-fighting in the year 2000. Continued dependence on this vulnerable support structure could well prove to be a crippling factor in the employment of 21st Century airpower.

The year 2000 presents exceedingly difficult Engineering and Services support challenges. To meet the challenges of the 21st Century, we must change traditional views, we must develop long-range plans, and we must begin the task of implementation now. The following recommendations succinctly articulate changes that must be considered.

- Develop ways to reduce or eliminate combat dependence on a limited number of fixed-site air bases and their vulnerable support structures
- Integrate weapon systems designs, weapon system employment concepts, and Engineering and Services support strategies to achieve maximum combat effectiveness.
- Complement the inherent mobility of weapon systems with an equally mobile Engineering and Services support structure.
- Organize support processes, support resources, and support structures for war-fighting, and operate in peacetime within that war-fighting framework. E&S

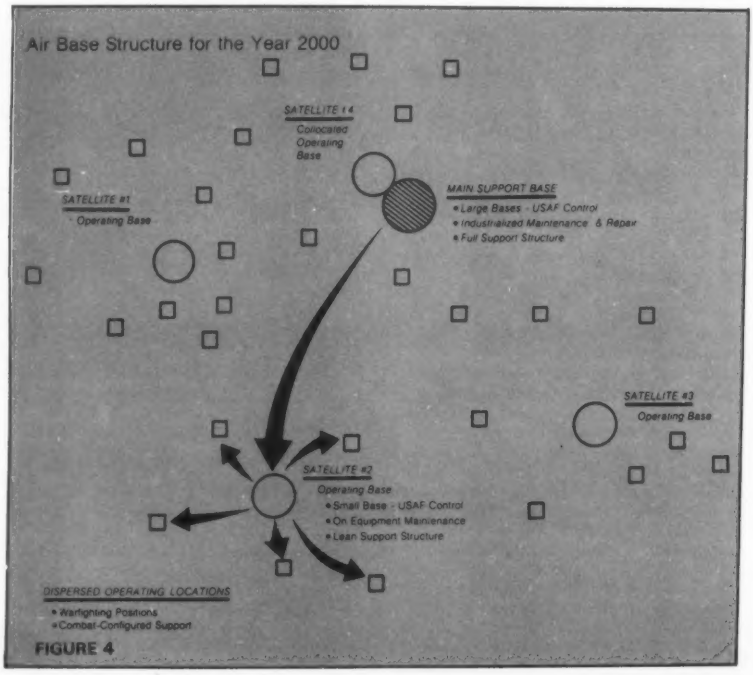


FIGURE 4

Capt. Dean Fox is a contingency operations officer for the Programs and Resources Branch, Programs Division, Air Force Engineering and Services Directorate. Before his current assignment he was executive officer to the commander of the Armament Division, Air Force Systems Command, Eglin AFB, Fla. Prior assignments at Eglin include serving as director of corporate planning for the commander and deputy base commander, and assistant chief of civil engineering operations for the Eglin auxiliary fields. He earned his bachelor of sciences degree in Civil Engineering at the Air Force Academy in 1972. He earned his master's degree in Public Administration from Troy State in 1979.

The Physical Plant in the 1990's

A VIEW FROM THE SECRETARIAT

By James F. Boatright

As the Deputy Assistant Secretary of the Air Force for Installations, Environment and Safety (SAF/MII), my office serves as the focal point for the Secretary on all matters pertaining to these areas of responsibility. We provide policy and guidance to ensure a cost-effective base structure and an efficient and safe physical plant that enhances Air Force operational capability, readiness, training and the quality of life for Air Force people. This is accomplished in accordance with the policies of the Administration and in full consideration of Defense Guidance and the desires of the Congress

Chain of Responsibility

I work very closely with the Director of Engineering and Services and the Director of Programs and Evaluation, as well as other functional representatives on the Air Staff, in defining and constantly updating this comprehensive perspective. I am responsible to the Assistant Secretary of The Air Force (Manpower, Reserve Affairs and Installations), the Honorable Tidal W. McCoy. He was appointed by the President and was confirmed by the Senate and has statutory authority and responsibility for these areas of Air Force programs and activities. He is one of three assistant secretaries serving with the Secretary of the Air Force, the Honorable Verne Orr.

It is Mr. Orr's or Mr. McCoy's responsibility to provide leadership and control and to translate the policies and initiatives of the Administration into major policy guidance and goals for the Air Force. It is the responsibility of my office to assist in this endeavor in those areas of responsibility for which I have been charged. To do this we fold new policies and initiatives into our long-range perspective and develop appropriate guidance and adjust our course and emphasis as necessary.

As a management aid, the Assistant Secretary has established a goals and objectives program. Within this program we have a series of seven goals related to the installations, environment and safety areas. (See Figure 1) Each of these goals has a series of objectives which become the focus of this management program. This program has been endorsed by the Secretary and is an integral part of our overall management effort.

As the Air Force Engineering and Services community looks toward the future, a better understanding of the perspective of the Secretariat should be helpful. A review of the basic thrusts of our goals and objectives will enhance such an understanding. Thus, the remainder of this article will be devoted to discussing these goals and objectives.

Quality of Life

This goal is particularly important to understanding the direction intended by the Assistant Secretary for the physical plant in the future. Its importance is obvious to anyone who has heard Secretary Orr or read his interviews in the press. The Secretary is a staunch proponent of improved quality of life for Air Force personnel. A major effort in improving the facility-related quality-of-life aspects is, therefore, a keystone in our overall program. In addition, the attitudes of Congress currently support the Secretary's thrust in this area, making quality-of-life projects good contenders in the annual military construction program. Our objectives reflect this situation and indicate where emphasis should be placed by the Air Force.

Family housing in the CONUS and overseas is a subject of direct concern to the Secretary. He has made few visits to our installations without afterwards commenting specifically on his impression of the housing situation. When he addressed the Air Force Association's national convention Sept. 15, 1982, in Washington D.C., the Secretary summed up his feelings with the following statement:

> ***"It costs us about $1 million to train a fighter pilot. It doesn't make sense to lose a $1 million pilot for the lack of a few thousand dollars spent for decent housing. This situation is something that General Gabriel and I are working hard to correct."***

The Air Force must ensure that adequate, modern housing for both families and those unaccompanied can be provided to its personnel. This can be done in a number of ways. We must acquire more adequate assets, either through military construction, leasing or promotion of increased civilian community housing. To do so effectively demands tht we understand the true scope of the problem so that we can:

1) assess our requirements against various acquisition strategies and select and concentrate on the strategy with the highest probability of success; and

2) justify our requirements in solid fact before OSD and the Congress.

Toward this end, I have established objectives of conducting comprehensive

reviews of family housing requirements both overseas and in the CONUS.

Once requirements are well defined, various options for acquiring that housing will come into play. Upgrading existing assets to modern adequacy is an obvious approach. I have established an objective related to thorough funding of our existing backlog of such improvements through the five-year planning, programming and budgeting cycle. Objectives for both family and unaccompanied housing are being addressed.

Part of the CONUS family housing objective is the investigation of imaginative means of funding new assets apart from the military construction program. A new initiative already under study would enable the Air Force to enter into long-term lease agreements and thereby promote the construction of Air Force-dedicated housing by civilian entrepreneurs in the communities adjacent to our bases. Congressional action is specifically required to enable the Air Force to do this. It was initially sought during the FY-83 Congressional review but was deferred for consideration next year.

In the area of overseas family housing, the Air Force must continue to rely primarily on military construction ôr on build-to-lease agreements where such can be shown economical. Overseas locations present the worst housing problems facing the Air Force. This will continue to be true into the foreseeable future. Special allocations of additional lease points to the Pacific Air Forces in the coming years are intended to enable more accompanied tours for Korea and Okinawa. The necessary community support facilities must be budgeted through the military construction program, especially for Korea. Additional lease points must also be programmed for the Philippines.

Quality of life, especially during off-duty hours, is highly dependent on the availability of quality facilities to house the morale, welfare and recreational (MWR) activities of our bases. I am pursuing an objective that would establish a comprehensive five-year plan for upgrading, replacing and providing the necessary facilities through a combination of appropriated and nonappropriated funding.

The source of funds for MWR facilities is of strong interest to the current Congress and can be expected to remain so through the 98th Congress. The committees and their staffs agree with our stated need for the facilities but are not convinced that we are approaching the problem in a coordinated fashion. We have guidance from the Congress. We have guidance from OSD. Sometimes the two seem to be in conflict. The Air Force must attack this situation head on. The way to do it is to develop a program on our own which follows the guidance of Congress and the guidance of OSD to the extent possible but which rigorously explains to one or the other why some deviation is necessary. No such program exists to date. My objective would establish the first. Air Force leadership must be able to address the MWR facility program as just that—a logical and acceptable program that would provide the facilities we need, at a reasonable pace and through a logical application of fund sources.

MWR facilities for the installations hosted by our partners in the total force policy, the Air National Guard and the Air Force Reserve, are vital to the missions of these reinforcing arms but are currently disorganized when viewed across individual base boundaries. I have initiated a review which will lead to greater uniformity of such facilities throughout the Guard and Reserve and thus make our program more cost effective and defensible. At the same time, we will provide those necessary facilities for all to enjoy at the earliest possible date.

Quality of off-duty life is recognized as a matter of extreme importance to the Air Force by everyone concerned. Morale and ***esprit de corps*** will be measurably enhanced through a quality-of-life program that meets the total needs of our people and their families. The facilities and programs available to off-duty airmen and their families are as important to morale and, subsequently, to readiness as are the skills employed on the job.

To the strategists, tacticians and weapon systems designers, the message is quite clear. Do not forget the person who will eventually carry the burden and do not forget the things that person needs to make him physically, mentally and spiritually ready. These things are as much

GOALS

Quality of Life
• Enhance quality of life at Air Force installations through the modernization of existing housing and community support facilities and the provision of additional facilities as required

Design and Construction Management
• Improve the design and construction management of major Air force construction projects.

Modernization of Existing Physical Plant
• Enhance the efficiency and operational utility of Air Force installations through accelerated, prudent modernization of the existing physical plant.

Environmental Impact.
• Improve the integration of the environmental impact review process with Air Force decision making

Real Property
• Be fully supportive of the Administration's initiatives in the real property area while minimizing both short- and long-term adverse impacts on Air Force operations

Energy Conservation
• For installation energy, reduce the increasing financial burden that energy consumption represents. Also reduce the current vulnerability installations have to energy supply disruptions

Occupational Safety and Health
• To assure so far as possible every Air Force member and employee safe and healthful working conditions and to assess,when indicated, effects of workplace exposures and to actively participate in establishment of Federal Occupational Safety and Health Policies and Standards

Figure 1

a part of each weapon system or deployment plan as are the warheads, bombs or bullets to be released against the enemy. This is why both Secretary Orr and General Gabriel have placed at the top of the Air Force priority list: "to take care of our people."

I hold the improvement of quality of life as my first and most important goal. This prioritization must influence the thinking of Engineering and Services personnel as they plan for the future.

Upgrading the Physical Plant

This goal is mandated by the age of our physical plant. More that any of the armed forces, the Air Force relies upon its fixed bases as the platforms from which it fights. The Army and the Navy go to the sounds of the guns and largely carry their support with them. The Air Force alone must make detailed war plans during peacetime which include the fixed-launch and landing platform locations which will be used.

Dispersal bases and contingency airfields will be increasingly necessary in the conduct of our future, highly mobile air operations. We must not, however, ignore the condition of our fixed maintenance, resupply and direct support facilities. The Congress and the Administration both realize that our physical plant is aging and that we have previously paid, perhaps, just enough attention to its condition and upkeep to keep it operational. Thus it has become very expensive to maintain and operate and in many respects is on the verge of collapse. It has taken a few years to make everyone aware of this fact and the current posture must be exploited promptly.

I maintain the upgrade of the existing physical plant among my primary goals in the installations area. Included are the objectives of reducing the current backlog of maintenance and repair to a manageable level through increased O&M funding attention and the objective of obtaining sufficient MCP funding to do necessary large-scale modernization and replacement on a timely basis.

Upgrade of the workplace is the remaining area where facilities impact the morale of the airman. The workplace today, however, impacts more than morale. Today's complex weapon systems simply cannot be maintained in austere, unsuitable facilities with unstable power supplies and no environmental conditioning. Short-term fixes will no longer suffice in the support and maintenance of sophisticated weapon systems of today and tomorrow. Certain facility attributes, once perhaps considered luxuries, are now absolutely essential to the success of the work done therein. In this realization, we must seek the upgrade of all our operational and support facilities at the earliest practical time.

Efficiencies

The Assistant Secretary has established three goals basically aimed at improving or maintaining the efficiency of our physical plant. The first pertains to the efficiency with which we spend the limited dollars we are provided to design and construct the new facilities we need. The second pertains to how efficiently we use energy in the facilities we operate. The last has to do with the efficiency with which we use the properties underlying our facilities.

Every dollar we are afforded towards the design and construction of new facilities must be used to its fullest capacity. We cannot afford to waste dollars when our needs so far exceed the funds available. Wasted dollars not only represent lost opportunities for more improvement elsewhere, they have the multiplicative effect of drying up their source. This latter effect can result either from actual waste or, and of equal importance, from the mere perception of waste.

Both the Administration and the Congress are keenly sensitive to the efficient use of our resources. We can only expect this sensitivity to increase in the future as we attempt to maintain budget growth in the face of huge national deficits and real or perceived cuts in other budget areas.

I have established the objective of improving Air Force management of the design and construction of new facilities. The Air Force has recently experienced major difficulties on two construction projects of unprecedented scope and complexity. From the difficulties have grown Congressional distrust and caution which our immediate efforts must seek to dispel.

In the near future, we will face ample opportunity to re-establish our credibility with Congress. The Consolidated Space Operations Center (CSOC) facility at Colorado Springs will soon be designed.

We have numerous large medical facilities, with their inherent complexity and sensitivity, either under way or on the drawing boards.

Primarily, my objectives seek to place Air Force construction managers in more active roles alongside our statutory design and construction agents. They would also improve the procedures by which information required by decision makers would flow promptly and accurately to its required location. Finally, they would seek an improved definition of the role of the eventual user and clearly establish the points at which, and the conditions under which, the user could further influence the end product.

Facility energy conservation is an area where efficiency is vital. In the face of ever increasing utility bills, our need to conserve energy will surely increase as we approach the turn of the century. In addition to conserving our energy sources so they will be there when needed, the Air Force faces a unique problem of much less concern to the other Services. We must address the survivability of the umbilical cord through which most of our installations receive their energy form the civilian sources outside the fence. We must seek self-sufficiency to the extent possible and we must be prepared to perform our mission with the umbilical cord cut.

The Air Force must constantly be alert to the energy conservation technologies flowing from the efforts of our civilian counterparts and capitalize, where possible, to improve our own situation. Objectives established by my office would advance the facility energy conservation program of the Air Force in all of these areas.

Operating costs for the installations owned by the Air Force are continually increasing and can be expected to do so in the future. My office is responsible to the Secretary for the alignment of Air Force bases and units and as such must continually review the base structure to ensure that facilities and properties are used with the greatest possible efficiency consistent with the mission.

The current Administration is extremely sensitive to the value of properties held by the Services. Executive Order 12348, signed by President Reagan in February 1982, clearly demonstrates this sensitivity. The order requires the Services to survey all controlled properties and report any which are excess to their needs, underutilized, or not optimally utilized. Such properties would be sold with proceeds going to the Treasury to reduce the national debt.

The executive order is thoroughly consistent with the Air Force's historical approach toward the stewardship of lands entrusted to it by the public. During the 1970s the Air Force closed many installations and realigned its forces to a posture considered lean and ready. The current Administration's initiative causes us to reassess this posture and it will be done. There are properties at some of our installations that fall in the excess or underutilized categories. They must be identified but in a manner which does not detract from our operational capabilities and flexibilities and the long-term viability of these valuable national assets. Disposing of these properties would help reduce the national debt under the auspices of the executive order and will have the added benefit of streamlining our operations and

cutting our O&M costs to a minimum. I have an objective which would ensure Air Force compliance with the Administration's initiative and yet provide the necessary protection of our air bases.

In a similar vein, the Administration is concerned that the Services cooperate fully with civilian industry in regard to the right of mineral exploration and exploitation on Service properties both on and off shore. I have established an objective which would ensure full and complete support of this intiative and yet protect the operational viability of our installations.

Environment and Safety

I was recently given the responsibility within the Secretariat for all aspects relating to environmental protection and safety. My objectives, established in furtherance of Air Force participation in these programs, are designed to ensure Air Force compliance with the letter and intent of applicable laws and directives and with the initiatives of the Administration in these areas.

Full compliance with the National Environmental Policy Act (NEPA) will continue to be critical to our accomplishment of the major actions we will undertake. At this writing, for example, the Air Force is involved with the detailed environmental assessment action necessary to support the site-specific decisions still to be made for basing of the PEACEKEEPER missile in Wyoming. A thorough and complete analysis is essential to the eventual success of this program. Anything less is simply unacceptable to the Air Force and the American people.

The Air Force must keep in mind the serious nature of two possible consequences of failure to properly comply with NEPA on every major undertaking. We must avoid the trap of considering NEPA to be strictly a legal impediment to our desires. As holders of the public trust, we must fully evaluate our potential activities with an eye toward minimum disturbance to the environment. As civilization expands and the world becomes more and more affected by our every action, the need to be more and more sensitive to potential negative impacts becomes extremely important. Decision-makers must understand this charter and be fully informed before making major decisions. The objective established by my office would ensure that the environmental process is more fully integrated with the Air Force decision-making process.

The safety and occupational health of our personnel have always been and remain very important to the Air Force. People are our most important resource. In addition to our basic concern for the welfare of our people, we are also concerned with the waste associated with manhours lost and compensation costs due to accidents, and destruction and damages to our systems, equipment and facilities.

One difficulty with operating at the edge of technological advancement is that such can be extremely hazardous. This does not pertain merely to the pilots of our advanced aircraft. It pertains as well to the operators and maintainers of our complex support systems and the users of the many exotic chemicals we employ every day. Air Force leadership must be aware that potential dangers to our personnel exist in abundance. Some dangers may be difficult to recognize even under careful scrutiny but all become far more hazardous in the absence of such scrutiny.

My objectives are to generally improve the Air Force workplace and the awareness of all Air Force personnel toward potential dangers to themselves and their equipment. Within these objectives lies the opportunity for all of us to avoid unnecessary waste of a most valuable resource and to improve the working and living environment of our people.

The Message

In a broad view, my perspective of the future direction of the Air Force physical plant can be summarized in three general statements: 1) The Air Force must continue to logically pursue improvements to the quality of life of our personnel through upgrade of our severely aging physical plant; 2) the Air Force must continue to improve the efficiency with which we acquire, maintain and operate our facilities; and 3) the Air Force must continue to improve the way we execute our public trust in the preservation of the environment and the well-being of our people.

This direction leads to the physical plant of the future as I envision it. The facilities afforded Air Force personnel, both on the job and off duty, will be suited to their function and conducive to high morale and readiness without being goldplated or extravagant. Our basing posture will be streamlined to the absolute minimum amount of property and improvements required to do the job. The Air Force will have reduced the cost of acquiring, maintaining and operating the physical plant to the minimum required and be able to statistically verify those costs. Major new undertakings will not begin until their environmental impacts are fully understood by the decision-makers. The Air Force will live in harmony with the environment, frequently contributing to its improvement. Our personnel will function in the safest environment possible and our leaders will be ever conscious of their responsibility to sustain that situation.

As a member of the Engineering and Services community, you will personally be involved in the multitude of tasks to be completed along the way. You must be convinced that the admittedly rosy picture painted above is not a dream world and is not impossible to achieve. On the contrary, it is absolutely essential and achievable. As I see it, there exists no other option if the Air Force is to continue its vital role in the defense of the free world.

Occasionally during the coming years reflect upon this perspective. It should help you plan and direct your individual contribution. Without your continued dedication and support we won't get there.

E&S

James F. Boatright is the Deputy Assistant Secretary of the Air Force for Installations, Environment and Safety. He served from June of 1976 through May of 1979 as the deputy for Installations Management. He began working for the Director of Air Force Civil Engineering in 1966 as project engineer for Air Force construction in Vietnam. He served in progressively higher level responsibilities, eventually moving up to the Secretariat. He holds a bachelor of sciences degree in Civil Engineering, and served in the Army Corps of Engineers.

CESMETtips

CESMET TIPS

The Air Force Civil Engineering and Services Management Evaluation Team (CESMET) reviews, evaluates and assists Base Civil Engineering and Services functional areas in accomplishing their mission in the most effective and efficient manner. Team members are Col. Duane Knutson, Team Chief; Lt. Col. Ray Munn, Supply; Maj. Laddie Amatulli, Civil Engineering; Maj. Dave Ehlers, Budget; Maj. David Safrit, Contracting; Maj. Jim Blanco, Services; Capt. Katie Counts, Personnel; SMSgt. Eddie Woodard, Civil Engineering; CMSgt. Gene Salisbury, Services; and SMSgt. Chuck Risinger, Fire Protection.

CESMET presents Certificates of Outstanding Achievement to people it sees at bases which are doing absolutely "top-notch" work. Here is a list of the most recent recipients:

- **Mr. Barton Longrie**— USAF Academy, Outstanding VCO
- **Tinker AFB**— Best Prime Beef Program
- **Ms. Carolin Savage**— Sheppard AFB, Outstanding Billeting Manager
- **Billeting Staff**— Pease AFB, Outstanding Staff
- **Pease AFB**— Total Wing Involvement During Snow Storm
- **Ms. Willa J. Crum**— WPAFB, Best Individual Housekeeper

SERVICES

Television repair is expensive, and with two to 300 sets on your account it can be difficult to keep operating sets in the rooms especially when the sets become older.

Some bases have solved this problem by purchasing extra TVs and replacing (not repairing) a set when it breaks. All TVs are depreciated at an accelerated rate (i.e., a $500 set depreciated for five years would have a $100 salvage value after four years). All TVs, operative and inoperative, are then sold at a "NAF auction" where an operative set may sell for at least $200, resulting in a $100 profit. New sets are then purchased with the profit realized from the sale, current income and the money saved on repairs. In reality we are depreciating the TVs faster so that we can show a small profit, avoiding the expense and problems of repair contracts and most importantly, providing good customer service.

BUDGET

During the first day of CESMET's visit to Elmendorf AFB, the CE funds manager was asked to be available for discussions in the afternoon. Her reply was, "You'll have to excuse me at 1330 because I have a financial working group (FWG) meeting to attend." Our CESMET budgeteer, knowing that the base FWG was to meet the following morning, asked, "What FWG?" Her answer, "My CE FWG." Great idea! We have never before seen a formal FWG within a CE organization. Shop superintendents are members. We highly endorse this approach as a means of further decentralizing funds management. Financial management is a team effort. For more information on how they do it, call Ms. Gerry Jenkins, AAC/DEU, AUTOVON (317) 552-2830.

CONTRACTING

The base level working environment and relationships between the Engineers, Services and Contracting are becoming increasingly sophisticated and complex. This trend is partly due to the move toward more contracting out, enhanced data automation and increased workloads which task a relatively stable number of personnel. Innovative approaches and solutions to daily challenges should thus be solicited from all the troops. If necessary, we should even try to "stretch" our imaginations to work some issues. CESMET recently saw a good example of this "stretching" approach at Elmendorf AFB, Alaska. The military family housing (MFH) maintenance contractor at Elmendorf agreed to run the MFH U-Fix-It store at no extra cost to the government. This means that the BCE does not have to expend manpower resources to man this optional function. "Stretch" your imagination and see if you have some areas ripe for innovation!

MATERIAL CONTROL

How well are you supporting job order material requirements? Can you easily quantify the support you are providing? Are you getting better or worse? Where should you put your time to improve overall support? How do you communicate your overall support posture to Supply and Contracting?

To answer these questions, SMSgt. Stephen R. Bodnar of Sheppard AFB uses the following chart. (AUTOVON 736-2349)

Job Orders Awaiting Materials

	Days Awaiting Material							
	2	7	15	20	30	45	60	% exceeding locally established goals
Classification								
Emergency	12	4	2					11%
Urgent	23	17	7	3	2			4%
Routine	90	65	20	15	17	20	15	6%
TOTAL	125	86	29	18	19	20	15	6%
Local Goals								

Environmental quality R&D:

Investigating tomorrow's problems today

by Lt. Col. Michael J. Ryan

An Air Force base, like any industrial plant, must comply with federal, state and local environmental quality regulations. Since the passage of the National Environmental Policy Act of 1969, and the ensuing heightened public environmental awareness, a cascade of legislation, regulations and guidelines has enveloped our bases and this shows no sign of abating. Resources spent on environmental compliance now represent a significant burden to the Air Force and may adversely affect continued peacetime training operations and the timely deployment of future weapon systems. Thus, it is necessary to quantify the "real" environmental quality impact of our current and future weapon systems and bases, and devise methods to control, mitigate or remove any negative consequences

This is what the Environics Division of the Engineering and Services Laboratory (ESL) is doing through its aggressive environmental quality R&D activities. Over the last several years the Environics Division has had a return on R&D investments of nearly 50 to 1 on numerous projects! This does not include the unquantifiable help provided through our technological products and guidance to Air Force decision makers, nor the R&D spin-offs to other areas and applications.

The total Air Force environmental quality R&D program is a cooperative effort within the Air Force and between the other services. The DOD program is contained in Area Coordinating Paper (ACP) 42, Environmental Quality Research and Development, which provides broad management guidance and direction for future R&D efforts. ACP 42 requires periodic program review which serves as a central point of contact for the services to insure that complementing R&D efforts are consistent with those being funded by other federal agencies, such as the Environmental Protection Agency (EPA). The Air Force portion of the program is managed by the ESL, which has been designated by HQ Air Force Systems Command (AFSC) as the focal point for all environmental quality R&D efforts. To ensure

an integrated and complementing program, this additional tasking requires coordinated environmental quality efforts by 10 separate AFSC funded laboratories.

Let's now discuss the Environics Division's portion of the total USAF Environmental Quality program. Our mission is to develop the R&D technology base to provide:

- Methodologies and techniques for pollutant characterization
- Environmental assessment of these pollutants in transport, interaction and their ultimate fate
- Control methods to ensure peacetime mission accomplishment.

The program focuses on the environmental impacts of weapon systems and unique Air Force pollutants, and strives for the early identification of problems and alternatives. Timely mission accomplishment, cost and regulatory compliance are the underlying criteria for all our R&D efforts.

Our current R&D efforts are focused on three research thrusts, or aggregates of related R&D projects. These are: Hazardous Wastes, Air Force Fuels, and Assessment Technology. These thrusts, covering the breadth of the environmental sciences and engineering, represent a sound management approach that addresses our current major R&D requirements.

The objective of the Hazardous Wastes thrust is to create a data base on the fate and effect of toxic and hazardous materials, and to devise techniques to reduce and/or treat these materials in a cost-effective, environmentally sound manner. This thrust has three technical areas: recovery and reduction, treatment technologies, and facility decontamination.

- Recovery and reduction are directed toward preventing waste generation at the source. Recycling the wastes, or at least reducing the quantities generated, eliminates or reduces the need for treatment.
- Treatment technologies develop efficient, cost-effective treatment methods for ultimate residual wastes that cannot be recovered or reused.
- Facility decontamination develops techniques to remedy installation contamination events.

While past Air Force handling of its wastes was in accordance with approved procedures 10 to 20 years ago, new regulations and information on toxic effects have necessitated studies of past contaminant incidents and may lead to the removal and/or stabilization of chemically contaminated areas at several Air Force bases.

The Hazardous Wastes research thrust contains many R&D efforts directed at solving current and future problems. These efforts include paint stripper and PD-680 solvent reuse schemes, hazardous sludge reduction methods, electroplating waste treatment, solvent removal from groundwater, aquifer modeling procedures, and ***in situ*** treatment of past and future toxic chemical spills. These represent complex problems with many diverse issues that must be addressed: For example, the many toxic and inert materials that accumulate through the use-disposal cycle on a base, the location and magnitude of past environmental releases, and the material, manpower and skills available at base level. But the financial payoffs in solving these problems can be quite attractive, as will be shown later. Other aspects, such as restoring the usefulness of contaminated lands, or recovering and reusing strategic materials (e.g., chromium and cadmium), have payoff potentials which may defy quantification during national crisis situations.

A primary objective of the second R&D thrust, Air Force Fuels, is to create a data base on the environmental consequences of converting to alternate fuels, whether from broadened specifications of current fuels or from alternative sources, such as shale-derived fuel. This is an important effort since a mere one-cent-per-gallon savings on JP-4, resulting from a broadened fuel specification, will result in a cost savings of $35 million per year. Also, although emphasis on synthetic or shale-derived fuels has recently lessened, the DOD is contractually committed to purchase a significant portion of these fuels, and R&D is still directed by the AF Advanced Development Program for Future Aviation Fuels. We must be able to assess the environmental quality consequences of such fuel changes to both comply with federal law and to mitigate potential legal actions. Also, included in this thrust is the development and maintenance of the technical base necessary to assess the environmental impact of all Air Force fuels. As an example, ESL performed in-house and contractual research to describe the environmental fate of hydrazine fuels. ESL still maintains an active interest and expertise in this area and often provides technical assistance to the field. Active programs also continue to assess and quantify the environmental effects of nitrogen tetroxide (N_2O_4) and cruise missile fuels, as well as conventionally-obtained aviation fuels such as JP-4 and JP-8.

This research thrust also has three technical areas: atmospheric photochemistry, aquatic chemistry and emissions research.

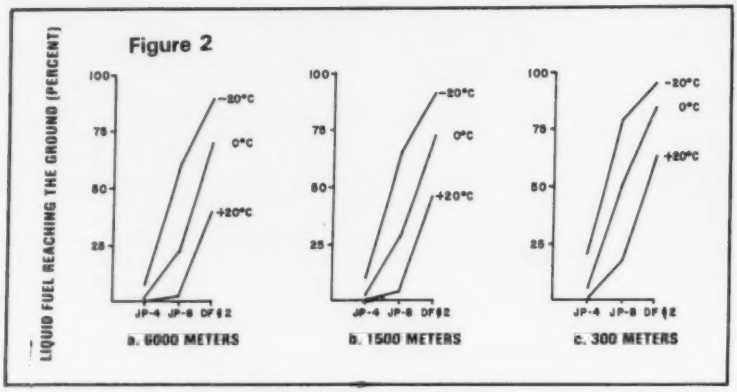
- Atmospheric photochemistry addresses the interaction of fuels and engine emissions with the atmosphere, and identifies the controlling parameters and mechanisms that determine their environmental fate and effect.
- Aquatic chemistry deals with the chemistry of fuels with water, soil, and soil-sediment interactions, with the goal of determining the phenomena that govern the environmental fate and effect of fuel spills.
- Emissions research investigates the effect of fuel type and combustor design on engine emissions.

Goals of the program are characterizations of the combustion parameters and mechanisms that control the quantity and composition of gaseous and particulate emissions in Air Force fuels and propellants.

The Alternate Aviation Fuels thrust addresses R&D areas that have not been previously investigated or were examined only in a cursory fashion. A detailed analysis of the composition of Air Force jet fuels and their gaseous emissions from turbine engines has not been accomplished (e.g., smoke particulate morphology and composition have not been measured). This causes tremendous complications in predicting the impact of future fuels on the environment. Fuel variability, caused by changes in source, supplier and/or broadened specifications, has not been previously addressed. Identification of the environmentally significant components is a necessity.

The payoff of this thrust is knowledge.

Figure 1: A small industrial waste treatment plant sludge bed.



Such knowledge constitutes a sound basis of fact and allows us to make valid and defendable environmental assessments, to weigh trade-off decisions, and to develop control strategies. Planning, based on valid technical data, is an approach that has been proven again and again. Needless delays from regulatory or court challenges are avoided, and costly, often marginally effective, "after-the-fact" treatment systems are eliminated. Finally, as we identify any critical fuel specifications, we can avoid unnecessary refining and the large processing costs previously mentioned.

Our third and final thrust, Assessment Technology, is developing the technical base and assessment tools needed to evaluate the impact of AF operations on the environment. This thrust has four technical areas:

- **Modeling of toxic vapors** deals with the atmospheric dispersion of toxic releases, with special emphasis on emissions from Titan II missiles, as well as the Space Shuttle.
- **Environmental quality models** addresses general environmental models for routine AF operations that allow us to assess the total scope of impact on the environment from flight operations, base ground transport, and industrial processes.
- **The environmental information network** effort concentrates on utilizing the existing technology base to improve the Air Force's capability for the transfer and integration of existing data and environmental models. The ultimate goal is a coordinated system for technical transfer of models designed for the user to the field.
- **The remote sensing** effort centers on the development of laser "radar" techniques which will immediately determine the extent of and quantify toxic or pollutant emissions from routine or emergency operations.

This final thrust encompasses numerous projects directed at predicting the environmental impacts, performing real-time pollutant measurements, and getting such environmental information into the hands of MAJCOM and base personnel. Of the technical issues involved, atmospheric modeling remains the most outstanding problem. Definition of accurate source strengths from spills, especially from hypergolic, high-heat release fuels, is poor. Also, the interaction of fuels, oxidizers and their combustion products is not well-understood. Interactions with the terrain, by all pollutants, and local ground turbulence are other issues. Real-time predictions, not post-mortem, after the fact analyses, are also critical to spill and pollution scenarios, especially at bases surrounded by people. We must have timely identification of toxic vapors and regulated pollutants, both in open and closed areas, and we must get concise information to field dicision makers. Payoffs come in support to weapon systems, safety, and environmental assessments. Getting such predictive tools to the field in a usable form will allow optimum planning decisions based on intelligent assessments, not blind "best guesses."

Lest you think our future plans within the laboratory have blinded us to the urgency of everyday Air Force concerns, let's review several of our recent accomplishments, which are meeting the needs of you, our customers.

We published and disltributed to the field a report on methods to reduce the quantity of sludges produced at industrial waste treatment plants (IWTP) sludge beds, such as the one at Hill AFB, Utah, shown in Figure #1. This is a significant first step, because the cost of disposing of our sludges has risen from $5 per ton a few years ago, to $85 per ton, or more, under the Resource Conservation and Recovery Act (RCRA). This report provided interim guidance on state-of-the-art means to reduce the quantity of hazardous sludges at the Air Logistics Centers of the Air Force Logistics Command (AFLC) and a cost savings of over $90,000 per year was shown possible at another AFLC facility, Tinker AFB, Okla. Additionally, an estimated potential cost avoidance of up to $12 million will be realized through application of these procedures and incorporation of our technical advice into the design of the new IWTP at Tinker AFB.

We are also pressing forward with our work for removing solvents, particularly trichloroethylene (TCE), from ground-

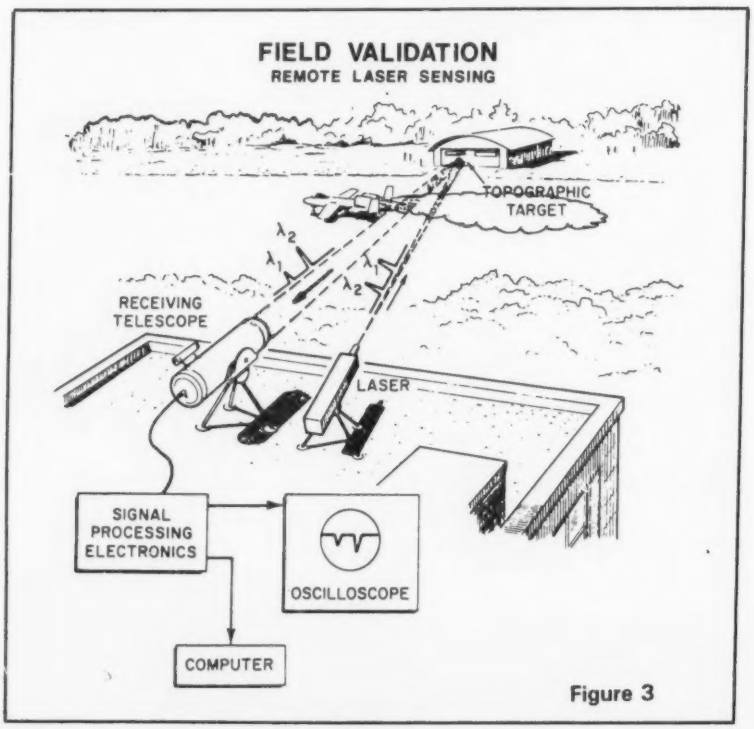


Figure 3

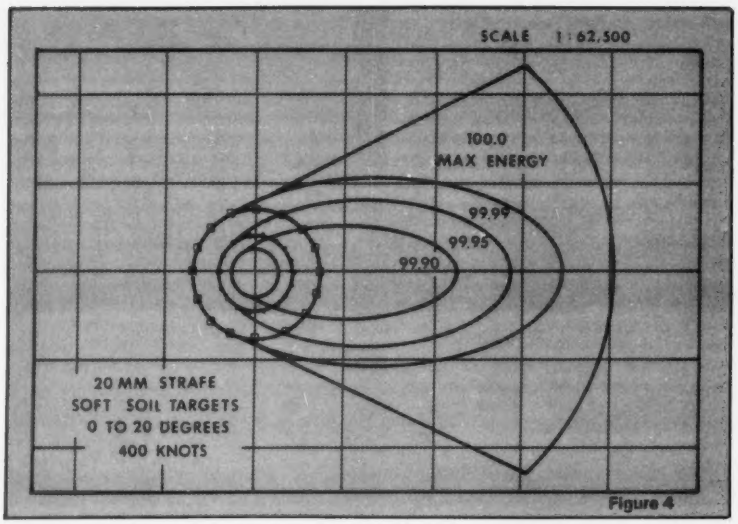


Figure 4

waters. This year we moved from laboratory to field studies of countercurrent air stripper technology for TCE removal. These lab studies indicated that this technique could be a cost-effective adjunct, or alternative removal method, for a serious TCE groundwater contamination episode at Wurtsmith AFB, Mich. (See "The Wurtsmith Test," by Maj. Stephen G. TerMaath, in this issue, for a detailed account.)

Groundwater contamination with TCE is a national problem. The Air Force problems are similar to those in the civilian sector, where TCE is assumed to be just the tip of the iceberg as far as groundwater pollution with organics is concerned. Other solvents have been, or will be found in aquifers under our installations, and we are working on an overall approach to encompass modeling, soil adsorption, field detection, and air stripping capabilities for multiple solvents of interest to the Air Force.

We have also investigated the control of JP-4 vapor emissions from storage tanks. At March AFB, Calif., we demonstrated a 90-percent recovery efficiency, using a vapor condensation method. At Ellington AFB, Texas, we demonstrated a greater than 99-percent removal using incineration. Our laboratory studies also indicate that the more volatile fuels, with higher alkylbenzene content (such as gasoline) are more photoreactive than JP-4, which in turn is more photoreactive than JP-8. This is significant relative to control of JP-4 vapor emission at our California bases, and we are preparing technical positions on the necessity and method for cost-effective control.

We also completed a long-term study with the AF Geophysics Laboratory on the effects of aircraft fuel dumping. Studies show that jettisoning should be done at more than 5,000 feet above the ground. As shown in Figure #2, this will result in no JP-4 reaching the ground on warm days and only two percent reaching ground on freezing days. On subfreezing days, 10-15 percent of JP-4 reaches ground unevaporated. The situation for JP-8, which is much less volatile, is considerably different, as substantially more fuel reaches the ground. On warm days three-to-four percent reaches ground, on freezing days 30 percent reaches ground, and on subfreezing days 70 percent reaches ground. This has a direct impact on the fuel dumping policy and procedures in Europe where JP-8 is utilized.

In addition, we have completed the analysis and draft final report covering accurate correlation of C-130 aircraft engine exhaust plume visibility with smoke emissions measurement. A major discrepancy between the AF goal and EPA regulation was resolved, and the EPA regulation was changed to reflect the AF value. The result was that the AF realized a cost avoidance of $1 million in development cost of an advanced, energy-efficient, turboprop engine and a potential hardware cost avoidance of $16 million. The Navy has a similar potential for savings. Furthermore, the contractor estimates a savings of $8 million in the civilian market.

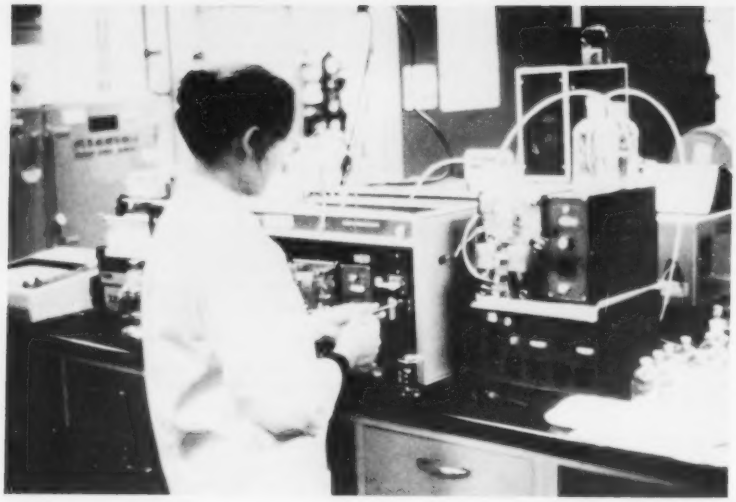
We also reached a major milestone in transferring to the field today's environmental models and data bases. A study was completed where the AF environmental modeling needs were identified and an approach to accessing available models and analyses was developed. This includes water spill, air quality, and toxic spill models. This effort resulted in a joint R&D/Investigational Engineering program in the Environmental Planning Office at HQ ATC in Fiscal Year 1983 for developing an environmental information network that will be user-orientated, rely on existing models/analyses and data, and will incorporate enhanced data display.

Another accomplishment was the achievement of an important milestone in the development of a remote sensing unit using laser "radar." Concentrations of carbon monoxide and ethylene were measured, at the levels expected, in the exhaust of an A-10 aircraft, operating at idle power, on the flightline, 1.5 miles away from the laser instrumentation as shown in Figure #3. This demonstrates the feasibility of field measurement with this new technology and its potential for further development into a transportable unit. Such a device could remotely identify and map toxic and pollutant gases and vapors in the field, thus making possible direct measurements, not guesses.

To capitalize on this emerging technology, we plan to extend the state of the art in application of laser technology to remote, real-time sensing of toxic vapors, chemical warfare agents, and pollutants, where they occur. A field study is planned to establish the capability of laser remote sensing techniques to perform three-dimensional pollutant mapping in the atmosphere. This study will use existing laser technology and advanced detection methods to provide range resolution. To obtain data on actual Air Force operations, the remote sensing system will be operated from a mobile platform.

The final accomplishment relates to an ordnance range planning hazard analysis model. The focus was to optimize use of our limited range resources. This model places quantitative tools in the hands of range commanders so they can assess risks and make decisions as to the use of ranges for existing or future ordnance, aircraft, or method of delivery. As part of the hazard analysis model, the first step was development of ordnance impact descriptors or "footprints" showing hazard probability contours, based on misses, not hits (see Figure #4). In this past year, the Environics Division completed work on the development of a set of 74 of these footprints that showed potential hazard areas resulting from air-to-ground weapons training activities. These footprints will be used to assess area requirements for most of the weapons training events flown by tactical air forces. Tests of this model at Nellis AFB, Nev., and at a smaller Air National Guard Range at Fort Indiantown Gap, Pa., significantly increased the capabilities and uses of these ranges. Many more training events can now be planned and accomplished on existing lands.

That, in a nutshell, is the Environics Division's program—your environmental quality R&D program for the future. We feel we have a successful program, in direct support of Air Force needs, with good solid accomplishments that feed a full-spectrum environmental quality technical base. Our laboratory is a center of excellence in many of the environmental disciplines and is ready to address validated requirements in a timely, cost-effective manner. Our products represent an expansion of the environmental quality technology base, and are provided to our Air Force customers



Laboratory Studies

Lt. Col. Michael J. Ryan is chief, Environics Division, Air Force Engineering and Services Center, Tyndall AFB, Fla. He earned his bachelor's degree in Civil Engineering and his master's degree in Environmental Engineering from Washington University. He also holds a master's degree in Systems Management from the University of Southern California and a PhD in Environmental Engineering from the University of North Carolina. A registered Professional Engineer in Texas, he is a member of the American Society of Civil Engineers and the Water Pollution Control Federation.

and interested military and civilian engineers via technical reports and presentations at professional meetings and conferences. Our goal is to have a stable, viable environmental quality R&D program that offers credible support, when needed in today's crises, and, more importantly, answers tomorrow's questions before they become crises. E&S

Air Force Team Fights Rust to Save Money

by Sgt. Lea Blake
Associate Editor

DID YOU KNOW the Air Force had a traveling team whose only mission is to stop rust—thus saving taxpayers millions of dollars and improving the quality of life for Air Force people? It does, and it's known as the Corrosion Analysis Team, or CAT.

From its headquarters at the Air Force Engineering and Services Center, Tyndall AFB, Fla., the team travels world-wide to fight rust. Annual Air Force corrosion losses now cost hundreds of millions in dollars. To fight that cost, the CAT regularly goes to each base to conduct special surveys.

"The purpose of the team is two-fold," said Maj. Ron Vogel, team chief. "Acting as an engineering consultant, the team analyzes base unility systems, identifies problems and makes recommendations to the base civil engineer. The CAT is not an IG team," he stressed, "but is a primary tool to prevent corrosion."

The team also trains base civil engineering people on procedures and techniques to reduce corrosion losses. A complete survey conducted by the CAT would include:

- Testing potable, or fresh water
- Checking the condition of water distribution systems and storage facilities, fire protection sprinkler systems, natural gas and liquid fuel (such as JP-4) distribution systems and storage facilities, and heating and cooling systems along with industrial water treatment.

During its normal two-week visit to each base, CAT also provides several other opportunities to base civil engineering folks. Corrosion awareness seminars are held to help civil engineers combat corrosion. Base technicians get hands-on training on how they can test these systems themselves.

CAT members also take these technicians along as they sample and test industrial water used in equipment like air conditioning and heating systems. Showing technicians how they sample, the type of equipment used and how to operate it, CAT members act as teachers. The team then explains the meaning of each test result and what corrective actions are needed, if any. Corrective actions could range from replacing filters on pipe systems to completely repainting a water tank.

According to Major Vogel, typical corrosion problems are misadjusted equipment, peeling paint, and rusted or scaled boilers pipes and air conditioning systems. "We check out corrosion prevention systems to insure they are protecting rather than hurting a system," he said.

Often the team will leave some of its testing equipment with local civil engineers. As the major put it, "We have the equipment to do gas and water leak surveys. We don't, however, have the time. If the base has such a problem, we'll train them on the equipment and leave it with them. Then the tests can be completed and the problem solved."

By traveling all over the Air Force to assist and train, CAT saves the costs of sending people to special schools. And, the team helps stop rust before it can damage expensive systems.

This team saves the Air Force money, while contributing to a better living and working environment for all Air Force people.

worth noting

ANNUAL WORKSHOP

The fifteenth Air National Guard Civil Engineering Association Workshop was held Oct. 26-29 at the Hyatt Regency Hotel, San Antonio, Texas. The host organization was the 149th Civil Engineering Flight, headquartered at Kelly AFB.

According to Lt. Col. Harold H. Blackshear, commander of the 149th CEF and workshop chairman, a wide range of topics was discussed. "The whole gamut of Air National Guard civil engineering was dealt with," he said. "We covered things like military construction, work control, energy conservation, master planning, fire protection and many others."

The workshop's keynote speaker was Maj. Gen. John B. Conaway, director of the Air National Guard. At the banquet on Oct 29, Maj. Gen. Clifton D. Wright, director of Air Force Engineering and Services spoke.

"The agenda for the workshop was heavy," said Colonel Blackshear, "and there wasn't enough time to cover everything we wanted to. Our days began at eight and ended at about five, but there, were those who started earlier and ended later."

About 500 people attended the workshop. Most of them were from the ANG. Representatives of the active Air Force major commands and the Air Force Reserve were also there.

San Antonio Mayor Henry Cisneros designated the city's Mayor Pro Tem Bob Thompson to welcome the workshop participants. "Mr. Thompson," said Colonel Blackshear, "also happens to be a lieutenant colonel in the 182nd Tactical Fighter Squadron, the flying component of our 149th Tactical Fighter Group."

PAY FOR IT OR REPLACE IT

Members of the armed forces shall be responsible and held liable for loss or damage to family housing, equipment, or furnishings caused by the abuse or negligence of the member or the member's dependents in family housing areas.

Although a bit rough it's true and has been published as an interim message change to Air Force Regulation 91-1. From now on, fire and fire damage to that house you live in on-base, will all be charged to you if you or your family are found negligent.

Upon notification of damages to government-furnished property, the housing manager will: "Prepare a reimbursable work order with a cost estimate covering the repair or replacement of damaged or missing property," states the IMC. If the estimated damages do not exceed $500 the occupant will be notified that:

- They are liable for the loss or damage
- Charges contained in the reimbursable work order are estimates and that they are required to pay the actual cost of repair
- They are authorized to replace or repair the lost, damaged, or destroyed property
- A report of survey will be initiated if liability for the loss or damage is not accepted, and
- They must acknowledge acceptance of liability.

Should the occupant decide not to pay the actual cost in cash, they may choose to replace or repair the lost, damaged, or destroyed property. But, the occupant must remember that should this option be selected, the housing manager gets to determine whether the replacement or repair is of equal quality and meets minimum Air Force standards.

Basically the regulation changed the definition of negligence. It now includes such situations as a grease fire or a broken window from a child's toy.

2750th TAKES RAWLINGS AWARD

The 2750th Air Base Wing Civil Engineering Squadron, Wright-Patterson AFB, Ohio, has won the 1982 Gen. Edwin Rawlings Award for energy conservation.

The award has been given annually since 1979 to the Air Force Logistics Command unit judged tops in energy conservation.

According to General Rawlings, the 2750th CES took the award for the success with a refuse-derived fuel program. "This idea of recycling trash into fuel is not only going to save coal and eliminate landfills, it has tremendous civilian application," said the general. "Often," he continued, "the military serves as a guinea pig. Programs we pioneer can and do have civilian uses." According to Wright-Patterson officials, the refuse-derived fuel program will eventually save 25,000 tons of coal annually and supply 25 percent of their base heating needs.

As to exactly what it takes to win the award named after himself, General Rawlings stated, "Personal qualities such as knowledge, leadership, integrity, reliability and hard work are essential for success. These qualities are what it takes to win the Rawlings energy conservation award."

PRIME RIBS PEOPLE TEAM RECOGNIZED

The Lackland AFB, Texas, Prime RIBS team recieved recognition for their efforts in the first Air Base Ground Defense Exercise, RIPE WARRIOR, held Sept. 10-17 at Camp Bullis, Texas.

The team, the only one in the entire Air Training Command, was supervised by **MSgt. James Brown.** Other members were **MSgt. Leon Clifton; TSgts. Rodney Brown** and **Samuel Jenkins; SSgts. Ronald Flynn, Michael Fairchild, Michael Limberg** and **Alfredo Martinez;** and **Sgt. Eric Shields.**

The exercise commander personally commended the team and presented each member with certificates of appreciation, signed by Gen. **Thomas M. Ryan, Jr.,** commander ATC.

Two hot meals were served daily during extended feeding hours with half of the RIPE WARRIOR cadre (about 300 members) eating each meal. The other half were given operational rations. The Air Force Master Menu was followed with at least two entrees offered for each meal.

Complete field equipment wasn't available, but through the initiative of the team and **CMSgt. Clifford Cook,** Lackland's food services officer, supplemental equipment was used from the local Air National Guard and Air Force Reserve units.

Members of the Lackland team have also been called upon to support Prime BEEF exercises at Laughlin and Williams AFBs. Each exercise has been under full field conditions with minimum support from the hst bases, according to **Col. Jack N. Whitmire,** director of programs, ATC/DE, Randolph AFB, Texas.

Air Force Installation Restoration Program

MAKING A "GOOD FAITH EFFORT"

By Bernard Lindenberg

As people are sensitized to the term "hazardous waste," there is a growing concern over the impact of hazardous materials on the environment. While Love Canal and the Valley of the Drums have commanded national headlines, there have been similar public concerns regarding past disposal of hazardous wastes in many areas of the world. One of these concerns was a 30-year old residue of DDT in Alabama that is now beginning to migrate. Another was the water of the Rhine River in Europe which was chemically contaminated to the extent that the river was able to function as a photographic developer. Hardly a day goes by that we do not see a television program or investigative reporting effort directed towards the problem of past hazardous waste disposal.

These past disposal practices have not been limited to private industry. The United States Air Force, due to its primary mission, has long been engaged in a wide variety of operations dealing with toxic and hazardous materials. Disposal practices were those which were accepted and used by all with little knowledge of the potential for future environmental impact. Federal, state, and local governments have now developed strict regulations to require that disposers identify the locations and contents of past disposal sites and take action to eliminate the hazards in an environmentally responsible manner.

Additionally, we must consider those areas in which damaged or corroded pipes or tanks have permitted solvents, fuels and lubricants to leak into the ground. In the Department of Defense and the Air Force, an aggressive program, known as the Installation Restoration Program (IRP), has been directed as a positive action to ensure compliance with all environmental regulations relating to past hazardous material disposal practices. In addition, Executive Order 12316 of August 1981 and implementing directives have made the IRP a basis for response actions under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, commonly referred to as the "Superfund" act.

The IRP is a comprehensive program to identify and evaluate past disposal sites and take positive action to eliminate the effects on public health and welfare in an environmentally responsible manner.

The Air Force policy to implement the IRP is to:

• Identify and fully evaluate suspected problems associated with past hazardous material disposal sites:

• Control the migration of hazardous contaminants:

• Control hazards to health or welfare that resulted from past operations and,

• Consider decontamination if feasible.

To implement the policy, a four-phase program has been directed by DoD. The phases briefly described are:

• Phase I — Installation Assessment (Records Search). During this phase, existing records are reviewed, interviews are conducted with those having knowledge of past operations at the installation, and those sites are identified which may require additional action to confirm the extent of contaminant migration. Specific recommendations are provided regarding monitoring parameters and locations based on a hazard assessment rating methodology developed for this program. The records search is an in-depth review of all activities that may have taken place on the installation.

• Phase II — Confirmation. This phase involves actual sampling and analytic work to confirm the presence and extent of contamination. The specific sampling protocol is tailored to each site situation based on the Phase I records search. An installation will normally have many identified sites within its boundary.

• Phase III — Technology Base Development. This effort includes containment/decontamination technology development, criteria development where there are no officially established standards, cost/benefit analysis of each alternative, and development of conceptual design together with the necessary environmental support documentation.

• Phase IV — Operation. The operations phase includes the remedial measures which are required to control identified hazardous conditions which may have a significant adverse effect on public health or the environment.

Phase I, III, and IV are the responsibility of Engineering and Services and the Phase II effort is the responsibility of the Medical Service, as defined by their environmental monitoring mission in Air Force regulations. This paper is directed toward Phase I of the Air Force IRP and will address how the program is managed, how priorities have been established, the methodology used for the Phase I records search, the Air Force Hazard Assessment Rating Methodology (HARM), and finally, the status of the Air Force Phase I implementation plan. (The Air Force Installation Restoration Program Management Guidance, which provides complete program information, has been provided to MAJCOMs for limited distribution.)

The Air Force program is managed by the Major Commands who provide the resources, develop priorities, coordinate with the AF Engineering and Services Center, and assure that program data is available in compliance with reporting requirements. Implementation of all program elements is based on policy direction from the Air Force Directorate of Engineering and Services, Environmental Division (AF/LEEV). Upon receipt of Air Force policy, the Air Force Engineering and Services Center provides the technical management guidance to ensure that the program is consistent throughout the MAJCOMs.

This guidance includes:

• Preparation of a standard statement of work for Phase I contracts

• Development of procedural guidance

• Development of a Hazard Assessment Rating Methodology to provide relative ranking between the various sites on installations regardless of command or location; and,

• Coordinating a public affairs protocol.

The Air Force Regional Civil Engineers (AFRCEs) provide the intergovernmental liaison required to make certain that program status is always available to EPA, state, and local agencies. The total Phase I program is coordinated with the Air Force Medical Service to assure that the Phase II work can proceed with minimal transitional problems. Because limited resources exist in house, most of the Phase I effort has been performed by contract. But major commands do have the option of using in-house resources if expertise is available.

To initiate Phase I of the IRP, each command assembled a priority list based on subjective criteria which included:

- Past installation missions
- Known contamination hazard
- Suspected contamination hazard
- Known disposal sites
- Environmentally sensitive conditions
- Possible land excessing; and,
- Public or political interest.

These MAJCOM lists were combined into an Air Force priority list. Sixty-six installations were identified and the Air Force has programmed all for completion of a records search by the end of fiscal year 1985. The criteria are not specifically ranked and any item can generate a reevaluation of the priority list. Based on the changing conditions, the Air Force updates its priority list periodically to reflect the current conditions. The commitment to complete 66 identified installations by 1985, however, has not changed.

When an identified installation is scheduled for a records search, a meeting is held with represen-

completed by the end of FY 1985, 38 installations were completed as of Nov. 15, 1982, 11 installations are in progress, and 11 installations are awaiting FY 83 meeting, which is conducted by HQ AFESC program coordinator, is to clarify all program elements to provide consistency throughout the Air Force. Program briefings are given to key installation personnel, and achieveable contract milestones are agreed upon.

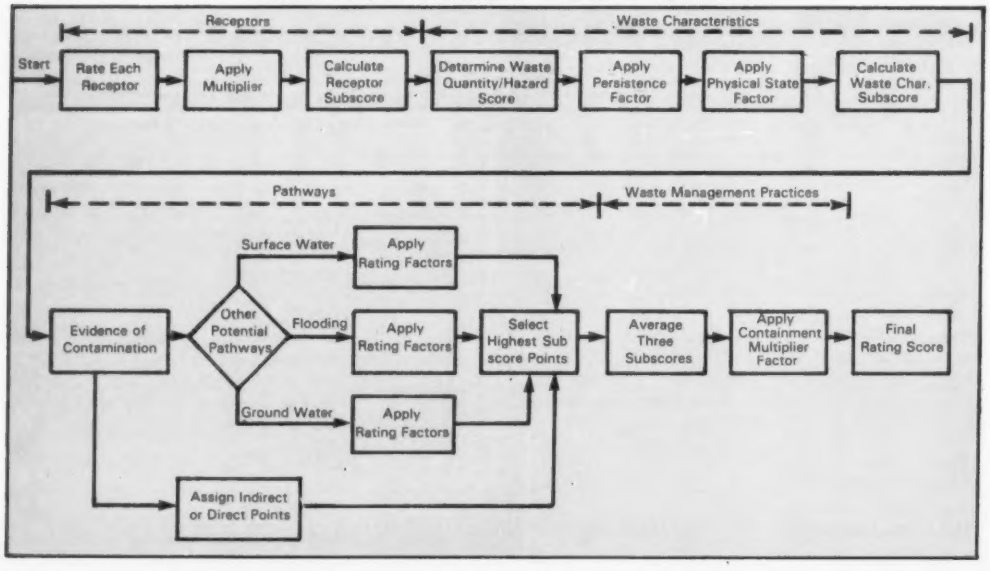
The methodology used in the records search is shown in a simple yes-no decision tree (figure 1). First, a review of past and present industrial operations is conducted at the installation. Information is obtained from available records such as shop files and real property records, as well as interviews with past and present base employees from various operating areas of the installation.

The next step in the activity review process is to determine the past management practices regarding the use, storage, treatment and disposal of hazardous materials from the various industrial operations on the base. In this part of the activity review, past landfill and burial sites are identified, as well as any other possible sources of contamination such as major spills of polychlorinated biphenyls or solvents, or fuel-saturated areas resulting from large fuel spills or leaks. A decision is then made, based on the information gathered, whether a potential exists for hazardous material contamination in any of the identified sites. If not, the site is deleted from further consideration. An installation will normally have many identified sites within its boundary.

For those sites where a potential for contamination is identified, a determination of the potential for migration of the contamination is made by considering site specific soil and groundwater conditions. If there is not potential for migration, but there is a potential for other environmental concerns, the site is referred to the base environmental monitoring program for further action. If no further environmental concerns are identified, the site is deleted from further consideration.

Of the 66 installations identified by the Air Force in January 1981, for Phase I records searches to be completed by the end of FY 1985, 38 installations were completed as of Nov. 15, 1982, 11 installations are in progress, and 11 installations are awaiting FY 83 contracting action. The status indicates that the Air Force program is on schedule and that the FY 85 objectives for Phase I of the IRP will be accomplished.

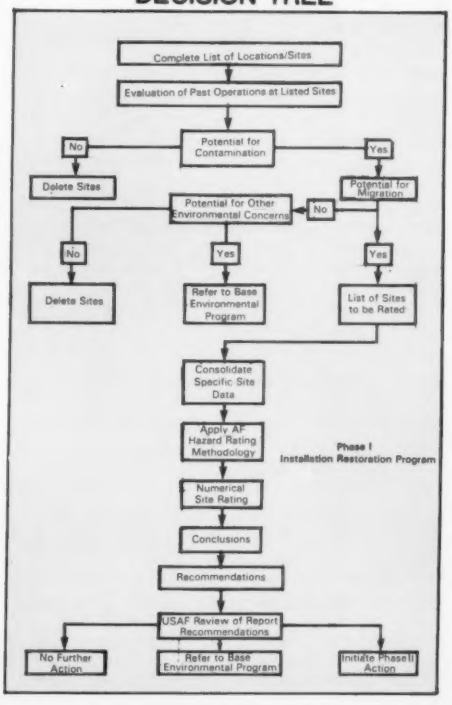
HAZARD ASSESSMENT RATING METHODOLOGY FLOW CHART



No one knows exactly what this program will reveal, but the Air Force wants to make every good faith effort to assure that we identify our problems related to past disposal practices, and make sound engineering evaluations leading to remedial measures. E&S

Bernard Lindenberg is the hazardous waste program manager for the Air Force Engineering and Services Center, Tyndall AFB, Fla., and is the engineering program coordinator for the Air Force Installation Restoration Program. He holds a bachelor of science in civil engineering from the University of Oklahoma, and a master's degree in environmental health from the University of Minnesota. He is a registered professional engineer in the states of Oklahoma and Texas. He served as a sanitary engineering officer in the Army Medical Service during World War II, the Korean Conflict and Vietnam. He was involved in the U.S. Army Civic Action Program in South America for which he received awards and commendations from six countries. He retired from the U.S. Army as a colonel in 1972.

DECISION TREE



If there is a potential for contaminant migration, then all site data is evaluated and each of the identified sites is rated using the Hazard Assessment Rating Methodology (HARM) (Figure 2). The site rating indicates the relative potential for environmental impact at each site.

HARM uses data readily obtained during the records search. As with other methods, four aspects of the hazard posed by a specific site are considered: the receptors of the contamination, waste characteristics of the contaminants, potential pathways for waste contaminant migration and waste management practices such as containment.

Each of these categories contains a number of rating factors that are used in the overall hazard rating. The receptors category rating is calculated by scoring each factor, multiplying by a factor weighting constant and adding the weighted scores to obtain a total category score.

The waste characteristics category is scored in three steps. First, a point rating is assigned based on an assessment of the waste quantity and the hazard (worst case) associated with the site. The level of confidence in the information is also factored into the assessment. Next, the score is multipled by a waste persistence factor, which acts to reduce the score if the waste is not very persistent. Finally, the score is further modified by the physical state of the waste. Liquid wastes receive the maximum score, while scores for sludges and solids are reduced.

The pathways category rating is based on evidence of contaminant migration or an evaluation of the highest potential (worst case) for contaminant migration along one of three pathways. If evidence of contaminant migration exists, the category is given a subscore of 80 to 100 points. For indirect evidence, 80 points are assigned and for direct evidence, 100 points are assigned. If no evidence is found, the highest score among three possible routes is used. These routes are surface water migration, flooding and groundwater migration. Evaluation of each route involves factors associated with the particular migration route. The three pathways are evaluated and the highest score among all four of the potential scores is used.

The scores for each of the three categories are then added together and normalized to a maximum possible score of 100. Then the waste management practice category is scored. Sites at which there is minimum containment can be reduced by five percent. If a site is contained and well managed, its score can be reduced by 90 percent. The final site score is calculated by applying the waste management practices category factor to the sum of the scores for the other three categories. The conclusions supported by the hazard rating determine what recommendations are made for follow-on actions. These recommendations are reviewed and evaluated and requirements are identified to the Medical Service for inclusion in Phase II of the IRP.

DESIGN EXCELLENCE FOR THE TWENTY-FIRST CENTURY

by H. Perry Sullivan, Jr., Editor

The Air Force of the 21st Century will be a combination of facilities ranging from the super-modern to century-old structures, and the challenge will be to adapt the old to new mission requirements while designing new facilities which embody new concepts, expressions and ideas.

More than 100 representatives of the Air Force, the other armed forces and industry met last June as the U.S. Air Force Academy, Colorado Springs, Colo., at the first USAF Design Symposium, hosted by the Air Force Director of Engineering and Services. In the weeklong briefings, presentations and panel discussions several directions emerged as predominant considerations leading into the next millenium:

- Most Air Force facilities extant now will still be in use, and without aggressive modernization will constitute a cash and utilities drain.
- Future facilities will benefit from today's drive toward excellence in terms of life-cycle costing, improved mission efficiency, increased adaptability as missions change, and better quality of life for the people who must use or occupy facilities.
- Greatly improved communication, cooperation and understanding is needed between those who require the facilities and will operate them, the Air Force programmers, the construction agents, and the firms which design and build them.

Underlying the evolution of the USAF in the year 2000 will be dynamic forces involving energy cost and availability, innovations in the process of design, consideration of the prevalent architectural themes on or around our bases, exciting new vistas offered by computer-aided design, and a strong emphasis on enhancing the capabilities of the current and future Air Force people involved in the facilities acquisition and design process.

Energy and Utility Systems

Alternative energy concepts will be a major feature of future designs, including solar, wind, on-base fuel cells, possibly magnetohydrodynamic efficiency enhancement and co-generation of both heat and electricity. Coal-fired technology will include various fluidized bed applications. Burning refuse will be an actively considered feature. Use of wood chips and forest by-products when available as a heating supplement will also be tested. Flammable petrochemical wastes which do not threaten the environment when burned will be incinerated with an energy yield. Environmental protection includes sulphur emission removal with a dry flue gas system and also using the wet sludge system. Combination fuels will be tried, including mixing coal and fuel oil.

Wasted heat and costly repairs are maladies of ground distribution systems. The Air Force will encourage shallow, concrete-lined trenches with mains trestle-mounted inside. Properly engineered, this provides protection from water infiltration into insulation jackets and minimized corrosion. The minor amount of waste heat can be used to remove ice from sidewalks, roadways and ramps. Easily accessed and repaired above-ground distribution systems have proved successful where wartime hardening or aesthetic considerations are not a factor.

There will be a strong emphasis on good industrial design of heating and air conditioning plants, featuring ease of access and maintenance, safety, and consideration of future increases or decreases in demand.

Energy control systems will be a major emphasis area. First, existing systems must undergo systematic adjustment, repair and upgrading. People will receive better training in control system work. Then, better systems must be developed to handle heating, air conditioning and ventilation.

Electrical circuit protection will increase in importance. New facilities coming on line must have comprehensive circuit analysis and application of better fault isolation. Analysis and coordination of relays will be required both in new facilities designs and in modernization projects.

Air Force design criteria will favor passive and other solar features which are inherent to any good design, including appropriate masking or exposure of interior spaces to the sun depending upon seasonal heating or air conditioning needs. Earth berms and earth-sheltered structures will be encouraged. One hospital design features earth protection from blast during wartime, also using the ground insulation for thermal modulation. Landscape architecture will become increasingly important, particularly placement and choice of trees and shrubs. Deciduous "orchards" minimize summer air conditioning requirements, shielding the earth's surface, providing up to 140 gallons per day of evaporative cooling per tree, and seasonally exposing adjacent facilities and the earth to solar warmth in winter.

While mission facilities are the object of intensive scrutiny for energy efficiency, housing and morale, welfare and recreation facilities will also receive attention. Efforts to shoreup infiltration in houses have reached the economic modeling stage, which will greatly facilitate prioritization of projects. Future housing must be built with greater concern for total energy consumption. Exchange and commissary facilities already feature reduced entrance/exit points, better insulation, improved heat and cool exchange between HVAC systems and energized display cases, and improved skylighting to optimize daylight and reduce interior electrical light demand.

The Design Process

Air Force projects funded under the Military Construction Program must by law be under the agency jurisdiction of the Army Corps of Engineers or the Navy Facilities Command for construction. A key to the successful relationships of the Air Force "customer," the agents and the contractor is the understanding of the complex MCP process.

Focal point for dealing with the agent is the regional civil engineer. Air Force regional civil engineers are located in offices serving the eastern, central and western regions, plus a special office at the Ballistic Missile Organization, Norton AFB, Calif. These offices become the spokespeople for dealing with the substantial issues which involve the base, major command, the agency and the architectural and engineering firms. Requirements must translate effectively across each of the synapse points involved in carrying out construction, plus the important regulatory and funding functions of the Air Staff, Department of Defense and the Congress. Added complexity is introduced when environmental considerations emerge, when there are special energy applications involving inter-agency funding, or when state and local governments are involved.

Keeping the responding A&E firms in the communications loop will be a major effort for the coming years, it was stressed. This effort ranges from providing successfully bidding A&E firms with better sets of design criteria to providing better forecasts of coming projects to all potential bidding respondents. Continuing involvement with the Air Force and other DOD construction acquisition agencies constitutes a major advantage for the firms which are persistently successful in responding to requests for proposals. Providing better information to other interested firms will be a significant challenge, both to educate and inform, and to bring fresh proposals, concepts and ideas into Air Force work.

Interior design of living spaces and administrative facilities has been an ill-defined area for many responding firms. One reason is the complexity of Air Force regulations and manuals governing acceptable furniture, carpeting, lighting and wall decor. Yet, perceived quality of environment may suffer. Self-image, pride in surroundings and the inferred prestige of excellence in interior design frequently translates into far greater involvement of facility occupants in the expression of care and maintenance of offices and housing. While intangible, the effects of good interior design can equate into millions of dollars in prevented maintenance expenditures Air Force-wide. Experts in acceptable design are available at some bases, most major commands and separate operating agencies, and at the Air Staff.

Comprehensive Design and Planning

People involved in the design and engineering effort both within the Air Force and among the supporting agents and firms should be sensitive to comprehensive planning and its impact upon total social cost as well as dollar costs.

Facilities are rarely independent in the context of the Air Force mission, and the complexity of the task is magnified with scale. Considerations include the gamut of design and engineering elements, and involve support of people, needed transportation, relationships with neighboring communities, impact upon the base community, as well as the delivery of essential services to the facilities coming on line.

Bases which do not have the in-house capabilities to look at their long range planning directions can call upon the Air Force Regional Civil Engineering offices which can offer multi-disciplinary planning assistance teams. The teams can assist in developing a baseline document which will greatly facilitate the orderly evolution of base facilities.

A major determinant of political success in the advocacy of major scale systems has been community perception. Implicit in the development of the M-X weapon system is a commitment by the Air Force to hear the affected publics and demonstrate that concern with effective community planning. This philosophy applies as well to mission and facilities changes at existing bases and the need to consider the total span of relationships with the nearby community structure.

Communication of Excellence

There is a need within the Air Force to better communicate the best in design and engineering excellence. Much of the mechanism is already in place in the form of the annual design competition.

Unfortunately, few can experience the facilities. Therefore, most of the evidence is pictorial or graphic. Pictorial presentation is the product of good equipment, photographic abilities, and the interest and time invested in the project.

Some A&E firms do their own photography. By-product use of these pictures for submission to the Air Force design awards competition is highly desirable in many cases. However, care should be exercised to insure that there is no penalty to the cost of the project.

Air Force documentation is highly recommended under AFR 95-3, particularly with new mission facilities coming on line. If properly forecast, Air Force audio-visual resources can be allocated to accomplish documentation. Usually the only cost incurred is paying for travel and TDY expenses for an airman photographer. If the documentation is significant enough to justify inclusion of the photos in Air Force archives, the funding will be paid by the Air Force Aerospace Audio Visual Service

"Organic" documentation by base photographers is controlled by two factors which can conflict with high quality. Photographers frequently are not available for day-long efforts, have little architectural and engineering experience, and are otherwise constrained in the type and size of product they can deliver. Contracting base photographic capabilities had the effect of locking these constraints into binding agreements.

There are few alternatives better than the architect or engineer who knows photography and the subject, and is willing to allow viewers to "experience" the subject through adroit use of camera, light and film. One medium for future consideration is videotape, which permits a far greater flexibility in demonstrating a new facility (AFR 95-2, Vol. 1). Its use, however, is not currently encouraged unless the facility is truly unique. Getting Air Force resources for this type of project involves extensive paperwork and numerous levels of approval. Still, some A&E firms have successfully used hand-held VTRs and cameras to achieve a new dimension in expression.

Exterior Design

Air Force bases represent many different periods of cultural and design influences, some bases having buildings more than 100 years old. Further, there are regional and local design influences which must be considered.

An aid to successfully-bidding A&E firms responsible for bringing new facilities on line or modernizing existing structures, is the catalogue of architectural features on base and in the community, showing structural details, decor devices, settings, form and other visual impressions, neatly captured in the 35mm color slide medium. Air Training Command success with the concept has been a major facilitator of cohesive design continuity, particularly in the architecturally typified areas such as Randolph AFB.

Firms should also be aware of the Air Force effort to end conflicting color exteriors, garrish and non-communicative signs which have little lasting value, and to produce a family concept through exterior decor. Many buildings suffer from gaudy, poorly designed or grotesque insignia painted on exteriors. At some bases, signs designating streets, buildings and office functions range from "early painted board" to "slick, modern and conflicting." Air Force uniform sinage policy is designed to improve communications while creating aesthetically pleasing signs. Building names, numbers or designations can be built into base architectural features using mosaic stone, tile or brick, or even using con-

trasting window glasses. However, care must be exercised to consider the permanence of building tenants, function and numbering before this is permitted.

Computer-aided Design

Design computers were once the province of the aerospace firm, the major A&Es, or the highly specialized computer support industries. Availability is now increasing, unit cost is decreasing, capabilities are expanding dramatically, and the success mold is motivating a revolution in the design process.

Within the Air Force, numerous concepts and ideas can be manipulated conveniently, using design elements loaded into the computer, permitting interaction before definition. Charting space requirements, building layouts, sketching out energy and utility distribution, heating, air conditioning and ventilation features are all greatly expedited. Analysis of construction cost and assessing of alternatives will be greatly facilitated.

Properly specified in the first-level design contracts, it can speed the work of the A&E, permitting a faster dialogue between the "customer," agent and the contractor.

CAD is now undergoing a range of integration into the design process that spans "evolutionary" to "revolutionary," and the equipment and software will not stabilize for some years.

People

Attracting, retaining and professionally enriching the capabilities of qualified people will continue to be a concern. At the college level, the Air Force and the commercial A&E alike must make available their best representatives to provide students with the most meaningful experiences possible—in studio design cooperative education opportunities, and as guest lecturers.

Once students elect the Air Force as a career, they will find that the "study or stagnate," imperative is just as important as in civilian industry. Many private firms pay tuition and expenses associated with professional enrichment. Few support it with the intensity and dedication of the U.S. Air Force through the Air Force Institute of Technology. Continuing education is available for engineers and architects in most areas affecting Air Force design and civil engineering work, including engineering management. Additionally, aspiring enlisted personnel who qualify for the Airman Education and Commissioning Program can complete degree programs at civilian institutions while earning entry into the commissioned ranks. Graduate-level education is offered both at civilian institutions and in residence at AFIT for officers, and at AFIT for civilian officer equivalent personnel.

Interesting students in Air Force related

We come together in a team effort as designers of the built environment regardless of our discipline. ...this group will basically control the built environment of the Air Force in the decades of the 80s and 90s as we close the 20th Century. The built environment, as it has throughout history, makes the statement of what our culture, society, our peoples believed in and sought as their legacy for future generations. You form the nucleus of leadership in design for the United States Air Force.

Tom Lewis, (Maj. USAFR), Architect, Florida Department of Transportation

In architectural education today one of the changes in the design studio has been the use of fewer hypothetical assignments and more "real world" type projects. We have found that students are more motivated if there is a real problem, an actual site than can be visited and analyzed, and there are individuals representing the "client" who will later review the solutions. ...These projects are of interest to the public agency since the students' concepts show a wide range of alternative solutions to the problem. This is useful in that objectives are clarified and later a comprehensive program can be developed. Student drawings, models and slides are sometimes later used by the agency to generate interest and to gain support so that the action to accomplish the project might be initiated.

Gayland B. Witherspoon (Lt. Col. USAFR)
Professor of Architecture
Clemson University

The architectural character of an Air Force installation evolves over many years and is the product of many designers. Often, the resulting visual hodgepodge of buildings is in conflict with the ideal of a base as a unified community. In today's rapidly changing world, there is a psychological need for a visually harmonious environment where our people live, work and play. Such an environment can be developed through analysis of past to present architectural and landscape influences couples with the use of dynamic management of design projects. (In the Air Training Command)... Architectural Environment Guidelines (AEG) were prepared for each installation and formed the nucleus of the architectural compatibility program.

Al Lew
Interior Design Specialist
HQ Air Training Command

work is beneficial whether they work eventually for the civilian A&E, for the Air Force as a civilian, or don the uniform. One leading university, Clemson, works cooperatively with the Air Force to expose students to design problems in which they can individually or in groups test their abilities against real-world challenges. Such projects have included diverse assignments on the Air Force Academy campus, and for Strategic Air Command and Tactical Air Command.

Summary

Advent of the year 2000 will have little direct impact on design and engineering of Air Force facilities. Most of the impact will be tied to a worldwide awareness of the new millenium, carrying with it a tide of innovation, exploration and discovery. These expressions will be limited by the private and public resources available to invest in future expositions.

Historically, the Air Force is a creature of the 20th Century. Its direct antecedents and immediate origins rest almost wholly within the last 100 years of the current millenium. From its almost fragile beginnings, the Air Force of today has grown into a world spanning power with its wings testing the spaces beyond. As the power of the Air Force has grown, its fixed facilities and human resources have declined. From the massive buildup of World War II, and the dramatic transition to a global deterrent force in the 1950s, the number of bases and people has steadily fallen. Part of this is due to the greatly enhanced capacities of weapon systems, muchly improved reliability, and the effective engineering of aircraft, missiles and supporting systems to achieve far greater yields. This has resulted in an almost geometrically rising sophistication, and far greater demands for skills and professionalism among Air Force people. Throughout the recent transitions of the Air Force from one technology to another, the facilities have been assumed. A concensus of the first Air Force symposium on design engineering is that the Air Force facilities of tomorrow must be developed and engineered with the same dedication to system integrity and capability as the weapon systems which operate from our bases, and the human resources upon which we depend.

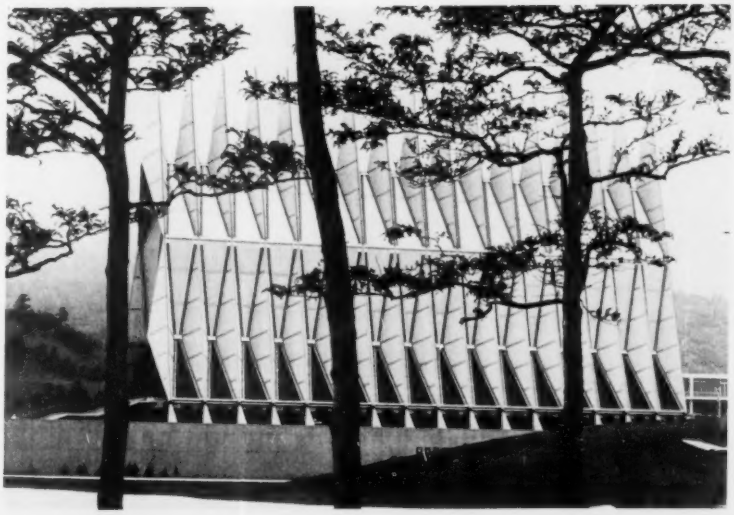
E&S

It may be surprising to learn that the seeking out and recording of a sense of order in our world is a predominant goal of traditional photographers. It goes without saying that beauty is another essential ingredient in both design and photographic products. In short, the primary goal of the architectural photographer is to aesthetically express the orderly visual qualities of a building in a complimentary way. When carried further, exceptional photographers can intuitively and consciously produce images which express personal visual goals so strongly that the building appears more successful than it really is.

Allan E. Hockett
Architect
Tactical Air Command
(TAC/DEEE - Design Branch)

New technology in energy systems and in environmental processes is now reaching the point of design confidence. We can predict the cost in terms of BTUs, and we can determine the life-cycle of any given system. The future will not be revolutionary in the application of new technology. The costs are very high, and many of our bases are quite old. We will establish priorities in the modernization of existing facilities. When new facilities are funded, we will apply state of the art energy and control systems.

G. Hammond Myers III
Chief, Utilities Branch
HQ USAF/LEEEU



Directorate of Engineering and Services

Current Emphasis

MILITARY CONSTRUCTION PROGRAM (MCP) CODIFICATION ACT—
was passed by Congress in July 1982. This act put the rules for execution of the MCP into the United States Code. With codification comes significant changes in flexibilities for executing the program, increased approval levels for Congressional notification of architect-engineer contracts and different rules for the exigent minor construction program just to name a few changes. We are working with OSD and SAF to determine the full impact of the Codification Act and hope to have guidance in the field shortly. (AF/LEEEC, Mr. Al Lowas, AUTOVON 297-6244)

THE FACILITY ENERGY CONSERVATION OFFICER'S HANDBOOK—
This "everything you ever wanted to know about being a facility energy conservation officer" handbook has been distributed Air Force-wide through the DE and PA channels. A small quantity is still available if you did not receive one or want to put one in your classics collection. (AFESC/DEV, Maj. Jim McEvoy, AUTOVON 970-6454)

ENERGY AWARENESS FILM—
The energy awareness film "Only Birds Fly Free," MB600048DF2, has been distributed to base level. Base level activities requiring this film should contact their base audiovisual libraries to order a copy. Activities without a base audiovisual library should contact: Defense Audiovisual Agency, Norton AFB, Calif., AUTOVON 876-7262. This is an excellent awareness tool. (HQ AFESC/DEB, Maj. Jim McEvoy, AUTOVON 970-6454)

AIR FORCE HISTORIC PRESERVATION WORKSHOP—
The Air Force Engineering and Services Center's Environmental Planning directorate is planning the first Air Force Historic Preservation Workshop for installation and major command historic preservation officers. The workshop is scheduled to be held at Randolph AFB, Texas, during the week of Jan. 17-21, 1983. For more information, contact AFESC/DEV. (AFESC/DEV, Ms. Scott, AUTOVON 970-6236)

POWER RELIABILITY ENHANCEMENT PROGRAM (PREP)—
The DOD has recently initiated a multi-year evaluation of Command, Control and Communication (C3) electrical power and diesel generation systems. The DOD executive agent is the Army Corps of Engineers and the technical program manager is the Facility Engineering Support Agency at Ft. Belvoir, Va. PREP objectives are to evaluate existing C3 facility power system problems and reliability, Electromagnetic Pulse/Interference withstand capabilities and deficiencies, and provide site civil engineers and higher headquarters a complete "scrub-down" of existing Air Force and Army technical manuals, regulation, and guide specifications relating to the operation, maintenance, construction and design of these specialized facilities. (AF/LEEEU, Mr. Aimone, AUTOVON 297-4082)

USAFE FOL TDY WITH SHORT TOUR CREDIT—
Prime BEEF and Prime RIBS people are needed to support a USAFE forward operation location for a 179-day TDY. Individuals selected and completing the TDY are awarded short tour credit and a new short tour return date in addition to obtaining valuable contingency experience. The primary Prime BEEF/Prime RIBS Air Force specialty requirements for the TDY are electrical, fire protection, structural, environmental, refrigeration, equipment, food services, and a civil engineering staff officer. (AFESC/DEOP, Capt. Eng, AUTOVON 970-6740)

THE AIR FORCE FACILITY ENERGY GOAL

for FY 83 is to achieve a 16 percent reduction in consumption (BTU/SF) over FY 75 levels. This is an Air Force goal, not imposed individually on the commands; however, each command must strive to meet their own internal goals if the Air Force is to achieve its overall goal. (AFESC/DEB, Maj. Holden, AUTOVON 970-6475)

MINOR CONSTRUCTION ACCOMPLISHMENT WITH OPERATIONS AND MAINTENANCE (O&M) FUNDS—

Commands now have authority to approve minor construction projects costing up to $200,000 instead of $100,000 using O&M funds. This resulted from recent legislation. (AF/LEEPP, Lt. Col. Barrett, AUTOVON 225-7774)

CIVIL ENGINEERING WORK CONTROL CHANGES—

Attention controllers! As of Jan. 1, 1983, the recurring work program changes and contains several new procedures.

- Actual hours, including travel time, will now be entered in the space provided on Part I (Current Week) of the Recurring Work Schedule. Travel time should be included since the standard hours determined by using engineered performance standards will include travel time.
- A completion indicator will also be entered in the space provided. A "C" indicates the work was completed (actual hours must be entered) and a "D" indicates item will not show up the following week as overdue. If the completion indicator block is still blank at the end of the week, the item will show up the following week as overdue.
- Labor inputs for recurring work can and should be entered over the CRT on a daily basis by the same individual entering labor. The labor date block on the frame will become the date last performed but should not change the next scheduled date as did the old program. (AFESC/DET, Lt. Col. Munn, AUTOVON 970-6111)

AFIT SEEKING VOLUNTEER INSTRUCTORS

The AFIT School of Civil Engineering is seeking volunteers to fill the following faculty positions for FY 84:

Military Positions

Degree	Background Experience
MS Engr/Engr Mgt	Varied—Base/MAJCOM/Air Staff
MS ME	Design, HVAC, Energy Systems
MS CE	Readiness, RED HORSE
MS Engr/Engr Mgt	Constr Mgt
	Ops, Programs, Design

Civilian Positions

MS ME	Controls, HVAC, Design
MS EE	EMCS, Power Distribution
MS CE	Water Treatment, Sanitary
MS Arch/ArchEngr	Constr, Project Mgt, Estimating
MS Mgt	Organization Mgt
MS Mgt	Real Property, Housing, Financial

If you are interested or know someone who meets these criteria and is interested in volunterring for consideration, please contact Lt. Col. Paul Richards, Associate Dean, School of Civil Engineering at AUTOVON 785-2004.

AUTOMATED FOOD SERVICE OPERATIONS SYSTEM (AFSOS)—

The prototype is currently being tested at Seymour Johnson AFB, N.C. The system uses a microcomputer and features real time processing in seven different modules. The test is scheduled for completion on Feb 28, 1983, and if successful, Air Force-wide implementation for 126 bases in planned for FY 84-86. (AFESC/DEHF, Capt. Cox, AUTOVON 970-6205)

Air Force Food Service in the 1990's

by Capt. Steven E. Berendt

The human link in the Air Force chain is both the strongest and the weakest. The individual's ability to adapt to changing scenarios, to control complex systems and to work in harmony with others is the cornerstone of every successful effort. A substantial part of the logistical baggage train that follows every military movement is made up of the support needed for survival and performance at maximum efficiency. Food and water must be available constantly to ensure peak performance, and people must be protected from the elements. This support must come unfailingly to every place where the Air Force could be called to fight.

The Air Force will be able to conduct quick and sustained combat air operations in the 1990's better than ever. Improved weapon systems and tactics are being developed at an accelerated rate each year. This is changing our ideas of what a suitable battlefield is, and the mobility, range and flexibility of potentially hostile forces.

The threat could be strategic in nature and the two Air Force legs of the triad would have to respond immediately. Missile crews as well as bomber and tanker personnel on alert must be ready with literally zero notice. The threat might come as conventional weapons are employed tactically. Air Force units already in place at the pressure point must prevail. The challenge could also come as a crisis anywhere on the globe, requiring high mobility and a speedy deployment. Intertwined in the response to such varied threats is the need for superior command, control and support.

Air Force food service in the 1990's must meet these mission challenges just as our personnel must respond to every threat. Food service, however, has dual mission not shared by many other Air Force organizations. Simply stated the dual mission is this. Food service personnel perform the support role for their units every day. Their tasking builds higher when the unit actually goes into action. This is especially true in operational command units.

Like the people it supports, food service will have to contend with environmental problems ranging form Southwest Asian deserts to Arctic tundra. Any climatic stress that threatens the effectiveness of aircrew members and support personnel must be offset by superior feeding and support functions. Long supply lines dictate that extraordinary food service will have to be provided. Rations with long shelf-lives, rugged protective packaging and high resistance to adverse storage conditions will be needed. Prepositioning plans are needed to counter the increasing ability of threatening forces to interrupt and interfere with resupply and response times.

Food service in the 1990's will meet another challenge—interoperability (the ability of our food service system to relate to those of our allies and the other services). Interoperability in resupply, shipping configurations, power requirements and equipment will be a force multiplier which will increase our ability to support combat troops. A lack of this function could cause a needless reduction of our combat effectiveness. Extensive plans to operate from allied host nation bases already in place in the 70's and 80's only underline the need to iron out any possible interface problems.

Besides conventional weapon attacks, food preparation, serving, storage and shipping operations will have to be able to survive nuclear fallout effects, chemical and biological attacks and recover quickly and completely. Air Force doctrine to operate and feed in a contaminated environment will include the need to receive water and nutrition while fully clothed in gear which protects our people from nuclear, biological and chemical agents, and to decontaminate all parts of the food system rapidly so full feeding can resume after an attack.

Equipment must be simple, reliable and less labor intensive because the number of meals fed in combat operations is inherently higher than that required in peacetime. Personnel available may not immediately match the tasking levels in the 1990's since manning standards are based on peacetime meals served. Also, management structures and unit sizes will be desinged to be rapidly augmented in the event of general mobilization or as the individual unit's mission dictates.

While combat commitments drive most peacetime Air Force units to practice and train for their wartime role, Air Force food service is not allowed this luxury. They must fufill a day-to-day mission substantially different from their wartime or alert role. This everyday food service at bases around the world will show many improvements over what we see in the 1980's.

Full food service contracting will be reduced. This will be done primarily to increase the number of military food service personnel who can be utilized to fill wartime contingency plans. Side effects of this active duty manning increase will include improved career advancement for all ranks and fewer overseas rotations for the senior enlisted ranks. Food service efforts to systematically augment manpower with technology will pay off in the 1990's. Simple computerized accounting, subsistence control and menu planning will be operational. Dining halls will use this new ability to track and predict customer preferences to focus more sharply on the desires of their clientele. Equipment, dining hall layout and manpower systems—taking their cue from the civilian sector—will be designed from the ground up to utilize manpower more effectively in the labor intensive food service function.

Technological evolution as well as improved management will free food service personnel to improve the meal and service rather than fight built-in inefficiency.

Meals will be highly acceptable to diners. Perceived value, variety and superior preparation techniques will rival the best commercial cafeteria, while speed, convenience and fast food availabilty will reflect the eating habits of many of our younger personnel.

This cost effective and highly responsive peacetime 1990's food service operation will be a real benefit to first-term airmen and other authorized personnel. A la carte systems and trends toward more individual basic allowance for subsistence will require dining halls to compete for customers with other base feeding activities and off base food operations.

As we compare and contrast the 1990's combat food service mission described earlier with the peacetime food service mission, the differences become obvious. Overcoming the contradiction inherent in the dual food service mission presents the biggest challenge to Air Force food service

leadership as it plans for the 1990's.

In peacetime only a limited number of personnel are authorized to use the dining hall. In alerts or at war, it becomes the eating center for everyone, increasing the number of meals fed by up to three times at some bases. Rations developed to meet the severe requirements of combat resupply mentioned earlier could never come close to providing the acceptability we've come to expect in peacetime. Manpower requirements for combat system plans seldom resemble peacetime manning where consolidation, fixed hours and a friendly environment allow economy of scale and increased efficiency. Cost becomes virtually no object during war but continues to be a limiting factor during peacetime.

Meeting this dual role will require a two-sided effort—parallel and complimentary plans which recognize the dual mission, and exercises designed to increase proficiency and effectiveness.

Air Force food service is developing highly skilled and motivated food service personnel who can meet the challenge and are mentally equipped to make the shift smoothly from peace to war. These personnel will provide the trained force for a limited threat response as well as the cadre for a general mobilization. Such initiatives as field feeding training for active and reserve personnel at Eglin AFB, Fla.; increased emphasis on the complexity of the feeding mission at the food service technical school at Lowry AFB, Colo.; and continuing exercises worldwide are all giving today's food service personnel the training and experience needed to meet the 1990's with confidence and ability.

Entire feeding systems are being planned that are tailored to specific mission requirements. This is done at the same time as the development of new weapons systems and tactics. Planning is designed to provide the high level of food service support needed. Two specific examples of Air Force food services' on-going efforts to remain responsive to specific system needs are: A truck-mobile kitchen to accompany ground launched cruise missile flights when they deploy; and an improved system for feeding small groups who support the widely separated ballistic missile sites.

Exercising wartime plans is the second part of the action being accomplished to meet this dual mission challenge. Exercise scenarios in the 1990's will continue to be clouded by the traditional command structure desire to provide a peacetime level of service and line item variety to personnel during exercises. This hampers food service training and system evaluation and creates an unrealistic picture of planned level of support, which in wartime may actually be very austere. Overcoming this problem will require a coordinated effort between major command, the exercise commanders and the food service operator. Overseas simulated combat deployments will continue and become more realistic as the U.S. defense policy of being able to meet the mobility threat is translated into more funds for exercises.

The end product of this planning and exercising will be Air Force food service systems in the 1990's with the following characteristics:

• **Flexibility and Responsiveness.** The complexity of international relations leaves no doubt that a situation requiring a response may come completely without notice. Air Force food service will be ready and able to respond at any level and in conjunction with any unit composition.

• **Tailored to Specific Missions.** Food service support will reflect the system it serves whether it be an ICBM, the ground launched cruise missile or a rapid deployment force. Extremely sophisticated enemy target acquisition and increased destructive capability means that food service in the 1990's will also meet the same requirements as its parent system for no distinctive infrared or electromagnetic signature.

• **Mobility.** Deployable food service in the 1990's will be designed to reduce cube and weight thus releasing cargo space for operationally required supplies. All systems will be compatible with dedicated aircraft for loading and movement.

• **Cost Effectiveness.** Live cycle costing and the long-term benefits of each new sub-system will be considered in every effort to upgrade the entire Air Force's food service system. Food service will yield tangible benefits in realistic capabilities and flexibility for the Air Force beyond its investment costs.

• **Superior Management.** Recruiting efforts in the 70's and 80's yielded many college trained hospitality specialists. Continuing higher education for our future leaders in hospitality management at prestigious civilian institutions and in industry under the education with industry program (EWI) will produce in the 1990's a trained, experienced management structure in Air Force food service which will be the envy of the civilian sector. Responsible career management of this priceless asset will give a high return on the educational costs because retention and morale, and therefore productivity will be higher than ever in the 1990's.

• **A Career Enhancer.** Air Force food service will be a point of difference from the other services for attracting and retaining talented personnel in the competitive recruiting environment of the 1990's. Top quality meal support will not only be a fringe benefit but it will represent to the airman the Air Force's commitment to support its people. The knowledge that there will always be refreshment and relief from the stress of mission-directed work or combat will be a great source of confidence to Air Force personnel.

Air Force food service in the 1990's will not exhibit these characteristics without efforts by the world-wide Air Force food service community. The goals of performance we strive for require improvement in our system. We are implementing our plans on many fronts.

Natural managerial evolution is our way of saying we have superior people with a pool of management and system knowledge. They are becoming more experienced while achieving higher grades and position of responsibility where they can put their ideas and experiences into actions and policies in pursuit of our goals.

We are learning from industry and civilian institutions. Each year our career field is improved by our people working for industry in the EWI program and attending civilian universities. We are keeping up with local restaurants and maintaining the fine association the Air Force has had with nationwide organizations like the National Restaurant Association, Society for Food Service Management, International Food Service Executives Association and the Research and Development Associates.

Unique military requirements are being addressed with Air Force and DOD Research and Development funds. New rations, equipment and feeding systems for the 1990's are in the works today.

The Air Force is recruiting and training better people each year. Food service not only offers a challenge for people while they are in the service but it provides them with one of the most marketable experience bases available if they decide to leave the military. The hospitality industry looks to continue to be a strong employment ground for the '90's. Top quality leaders at all levels will be required to meet the challenge of food service in the 1990's.

Finally, the Air Force food service command structure is making its objectives known and bring the entire services career field on line to help in the development needed to meet the challenge. Conferences, cross-talk and communications up and down the food service network are spreading the word. Basic instruction at Lowry AFB, on-the-job training in the dining halls and specific schools such as Prime RIBS field feeding training at Eglin AFB are also emphasizing this team approach.

It must be a team effort if we are to fulfill our part of the Air Force mission. Readiness, fighting and support go hand-in-hand. Air Force food service is moving ahead to attack the challenges the 1990's offer. E&S

Capt. Steven E. Berendt received a bachelor of science degree in History from the Air Force Academy in 1972. He was assistant commissary officer at Lowry AFB, Colorado, chief of Services at Thule AB, Greenland; and chief of Services at Camp New Amsterdam, the Netherlands. He attended Florida International University under AFIT and received a master of science in Hotel and Food Service Management in 1980. From December 1980 to June 1982 Captain Berendt was Air Force Engineering and Services Center's project officer at Natick Lab, Mass. He was the Air Force representative to the Joint Technical Staff on the DOD Food Research, Development, Testing and Engineering program. Captain Berendt is currently the chief, Services Career Management Team at AFMPC, Randolph AFB, Texas.

tecnotes

MOBILE AIRCRAFT ARRESTMENT SYSTEM— The Aeronautical Systems Division (ASD/AEG) is managing a program to develop a new aircraft arresting system which can be rapidly installed on pavement or natural soil surfaces. The new barrier will be used in contingencies where existing permanent systems are destroyed by enemy attack or otherwise rendered useless. Several candidate systems are currently being tested and evaluated. (AFESC/RDCR, Capt. Wallington, AUTOVON 970-6307.)

MULTIPLE CRATER REPAIR— A Prime BEEF team equipped with basic and supplemental equipment kits carried out simultaneous repairs of six craters at Eglin AFB in October. The crushed stone method was used, but FOD covers and AM-2 mats were not laid. A new organization of six (seven- to ten-man) crater repair teams was tried, supported by one hauling team and a FOD clearing team to sweep the MOS. The six repairs and the sweeping of a 5,000-foot MOS took three hours. Data from the test is still being analyzed. AFESC will publish a Technical Report. (AFESC/RDCR, Maj. Campbell, AUTOVON 970-6313.)

HYDRAULIC EXCAVATOR— A John Deere 690-B hydraulic excavator, mounted on a six-wheeled undercarriage, was fitted with a 12-foot side dozer blade and used to repair an exploded 25-foot crater (actual diameter) using the crushed stone method. The test was done at Tyndall AFB in November on a pad comprised of eight inches of unreinforced PCC overlaid with six inches of asphaltic concrete. The excavator used its dozer blade to push debris into the crater and off to the side of the pad. In 21 minutes it broke out and removed the upheaved pavement with its bucket. It dozed crushed stone from a nearby stockpile, roughly levelled it and then, its bucket replaced with a hydraulic plate compactor, compacted the crushed stone. Final grading was done with the dozer blade. (The blade control mechanism which should automatically maintain blade height was not working during the test.) The repair took 95 minutes. Allowing an extra 20 minutes for placing a FOD cover, a full repair would have taken 115 minutes, though is it confidently expected that with training this can be improved on. The repair was trafficked with 980 passes of the F-4 loadcart. This excavator is of the size planned for inclusion in the RRR supplemental equipment set. (AFESC/RDCR, Mr. Alexander, AUTOVON 970-6326.)

SYMPOSIUM— A symposium on the Interaction of Non-nuclear Munitions with Structures will be held at the USAF Academy, May 10-13, 1983. The symposium is being sponsored by the Engineering and Services Laboratory, AF Armament Laboratory, AF Weapons Laboratory, and AF Office of Scientific Research. For more information contact Dr. C. A. Ross, P. O. Box 1918, Eglin AFB, Fla. 32542, AUTOVON 872-5614. (AFESC/RDC, Capt. Wilson, AUTOVON 970-6275)

REVERSE OSMOSIS WATER PURIFICATION UNITS (ROWPU)— Representing a significant enhancement to E&S readiness, the Air Force has taken delivery of its first ROWPU equipment. This equipment is capable of treating saline and brackish water for which current purification equipment is ineffective. ROWPU are being procured to support potential RDJTF operations in Southwest Asia. ROWPU training will be conducted at the Sheppard Technical Training Center, the AFESC Prime BEEF training site at Eglin AFB, Fla., and the Harvest Bare training site at Holloman AFB, N.M. (AF/LEEPP, Maj. McMahon, AUTOVON 225-5701 or AFESC/DEOP, Capt. Smith, AUTOVON 970-6136)

CONCEPTS FOR HARDENING EXISTING RUNWAYS NEED IDENTIFICATION. With the advent of hardened aircraft shelters, runways have become prime targets to render air bases unusable. If feasible methods of hardening the runways can be identified and employed, the possibility of retaliation against attack will be tremendously increased. An R&D effort is currently underway to identify concepts for hardening existing runways against conventional air attacks. Once feasible concepts are identified, they will be tested with actual air-delivered weapons. (HQ AFESC/RDCR, Maj. Bretz, AUTOVON 970-6295)

TESTING TO VALIDATE AN AIRCRAFT-SOIL INTERACTION COMPUTER CODE is being conducted within the Air Force. This code will permit prediction of usability of soil airstrips for fighter aircraft operations and will be applicable to Alternate Launch and Recovery Surfaces and the Rapid Deployment Force. The code is being validated with an instrumented F-4 making low and high-speed taxi runs on soil test strips. (HQ AFESC/RDCR, Capt. Wallington, AUTOVON 970-6307)

THIN ASPHALT REDUNDANT SURFACES are being tested at two Air Force bases in the CONUS. A study is in progress to determine the thinnest asphalt wearing surface that can withstand alternate launch and recovery surface (ALRS) loading criteria (i.e., limited number of F-4 and C-130 operations). Air Force manuals require a minimum of three-inches which may be excessive for ALRS use. Field tests conducted on existing, low-use thin asphalt sections (shoulders and overruns) at Whiteman AFB, N.M., and Wright-Patterson AFB, Ohio, indicate between one and two-inches of hot-mix asphalt concrete will meet ALRS criteria. (HQ AFESC/RDCR, Capt. Kelly, AUTOVON 970-6306)

Civil Engineering Research and Development Issues in the Year 2000

by Lt. Col. John E. Goin

What will be the focus of civil engineering research and development 18 years into the future? When I asked myself that question, my first inclination was to break out the crystal ball. After reflecting awhile I concluded that civil engineering technology needed to support Air Force concepts of tomorrow is not a matter of pure speculation. It is a projection of current trends and we need not enter into the realm of science fiction to develop the civil engineering technology needed to support future Air Force operations.

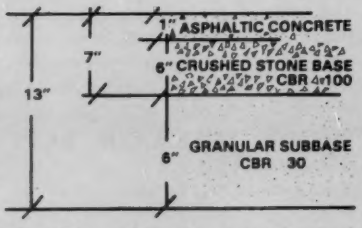
Modes of operation will no doubt change. New weapon systems will be online but we may very well be supporting systems existing now in the year 2000. Who could have thought back when the B-52 made its maiden fight that it would still be the air-breathing component of our strategic triad? Current trends indicate that future basing concepts will range from fixed decentralized ground stations to extra-terrestrial bases. Also, in the post-2000 era, we can count on having to maintain many of the real property facilities currently in the inventory. Regardless of changes in strategy or tactics in the outyears, civil engineering R&D must continue to be directed toward the readiness and wartime roles of the Air Force as it is now.

Twenty-first Century technology efforts are envisioned to include the development of the necessary materials, methods and equipment to support the following general areas:

- Advanced weapons systems support
- Future base concepts
- Space operations
- Operation of existing installations and systems

Advanced Weapon Systems Support

A critical need exists now and will become more paramount in the future to integrate civil engineering contributions into advanced weapon systems design. Civil engineering technology will provide the theory, techniques and design criteria necessary for trade-off investigations to optimize survivability and supportability. Specific areas of emphasis anticipated are: Survivability assurance and maintainability, optimization of maintenance and personnel requirements, reduction of energy usage, and integration of the weapon system into basing concepts.



Possible alternate launch and recovery surface design

Future Base Concepts

Technology will be required to support readiness, survivability, recovery after attack, sustainability, and endurance of both fixed and mobile bases. Focus must be on survivable, self-sufficient energy systems, physical security, limiting damage, material recycling, and effective fire protection and crash rescue. Also, technology must be available to assure that weapon support systems can be built, operated and maintained economically. Extension of the Rapid Deployment Force concept will drive the need for advanced technology to support worldwide deployments to forward locations with limited existing support facilities.

More conventional Portland concrete design.

Space Operations

Ground activities and extra-terrestrial operation will require the use of technology existing today as well as developing new technology for space support. Adaptation of technology developed by NASA will probably be enough for most ground operation requirements. However, new technology development will be required to address unique military operations (including launch platforms, living concepts, fuel storage and transfer, power, operation and maintenance, fire protection and life-cycle survivability). The survivability issue could be the greatest challenge. We must shift our thinking from conventional weapons and their effects to those of space age weapons such as lasers and particle beams.

Operation of Existing Installations and Systems

Technology must be developed to enable existing facilities to continue functioning in light of growing threats which are fostered in part by advancing technology. Critical areas include alternate launch/recovery systems, upgrading hardness, utilities redundancy and survivability and analytical and test techniques for assessing continuing survivability/vulnerability of weapon systems.

In the civil engineering arena a wide range of R&D efforts will be needed in the year 2000. The basic objective—providing support for placing weapons on targets—will remain unchanged.

Lt. Col. John E. Goin is presently the chief, Engineering Services Division, the Engineering and Services Laboratory, Air Force Engineering and Services Center, Tyndall AFB, Fla. His credentials include a bachelor's degree in Civil Engineering from the University of Kentucky, a master's degree in Engineering from Texas A&M (through the Air Force Institute of Technology), the Air Force Command Staff College, Air War College, and the Industrial College of the Armed Forces. The colonel has a total of 19 years on active duty and has been in the civil engineering career field the entire time.

People worth noting

NCO CONFERENCE

Chief Master Sergeant Robert J. Zahorchak, representing the Air Force Engineering and Services Center, Tyndall AFB, Fla., joined 32 other Army and Air Force senior NCOs at Headquarters Army and Air Force Exchange Service in Dallas, Texas, for a two-day conference in November.

AAFES extended the invitation to all senior NCOs from around the world to gather information on the needs of military personnel who patronize Exchange stores. The conference members also received an update on AAFES policies, procedures and programs.

Maj. Gen. Richard D. Murray, AAFES commander, said, "One of the most difficult problems is informing young service families about their Exchange. It is important they know what services are available to them, the savings offered and the benefits of using the Exchange," he said.

"You are in a position to carry the AAFES message to the troops—especially young soldiers and airmen," he told conferees.

Chief Zahorchak was excited about the conference and its final outcome. "Many new initiatives were brought before the AAFES folks," he said. "We (the senior NCO attendees) suggested things like getting major credit card systems in the BX and service stations, car rentals, and tour agencies, adding services now not available to our lower ranking enlisted people on-base. We hope AAFES officials will address these initiatives to the Congress when next they meet."

The chief also talked about present and future items available in the BX. "Congress puts the stringent controls on what can be stocked in our BX's, not AAFES. Congress also dictates that only top line and top quality items be stocked," he said, "But, the BX does have the lower ranking enlisted person in mind when they stock most items. They also have what is known as the 'best buy item,' an AAFES brand. These items are comparable to top brand items, but will sell at about 60 percent lower."

The one topic Chief Zahorchak stressed and hopes will become a major thought for the enlisted force was the AAFES complaint system. "When people do have problems with the store," he said, "they should take them to the manager. If a satisfactory answer isn't obtained there, they can and should take it on to AAFES headquarters in Dallas, Texas. There is even a toll free number to call (1-800-527-6789)! Their complaint system is a good one but it isn't used enough. Our enlisted people will find that they can change some things within the AAFES system by using that system instead of remaining quiet or complaining in the wrong direction—through the wrong system. If all else fails, then see the senior enlisted advisor of your unit. At least your problems can be heard and not kept in silent anger."

MAJOR TERMAATH GETS CFEE AWARD

Maj. Stephen G. TerMaath, chief Environmental Engineering Branch, Air Force Engineering and Services Center, Tyndall AFB, Fla., has been selected as the 1982 Environmental Engineer of the Year. The selection was made by the Conference of Federal Environmental Engineers. Major TerMaath's selection was based on a career of outstanding accomplishments, including his recent contribution to the development of an advanced air stripping technology for cost-effective cleanup of contaminated groundwater.

AFSC ANNOUNCES COMMAND AWARD WINNERS

Officials with the Air Force Systems command have announced their Engineering and Services award winners in various categories. They are:

- AFSC Services Managers of the Year—**Vernon F. Bergenheir**, chief of Services, Edwards AFB, Calif., Senior Manager; **SMSgt. Peter E. Loos,** food services superintendent, Hanscom AFB, Mass., Superintendent; and **MSgt. Timothy A. Oberhaus,** food services supervisor, Eglin AFB, Fla., Technician.
- Meritorious Achievement Award (military)—**Capt. Louis F. Hauck**, ASD, Wright-Patterson AFB, Ohio.
- MAA (Civilian)—**Jerry R. Rankin,** Eglin AFB.
- Engineering and Services NCO of the Year — **MSgt. Francisco Rodriguez-Negro,** Edwards AFB.
- Engineering Civilian Manager of the Year (up to branch chief)—**Robert Borjon,** Edwards AFB.
- Engineering Civilian Manager of the Year (branch chief and up)—**Margaret Luckie,** Eglin AFB.

Also in the winner's circle were Eglin AFB's Civil Engineering Squadron, selected as the command's Most Outstanding Civil Engineering Squadron; and Brooks AFB, Texas, which received the AFSC Innkeeper's Award.

STAFF MEMBER PASSES ON

Mrs. Kathryn Anita McDaniel, who worked on the ***Quarterly*** staff in 1980, died in Panama City, Fla., Nov. 28. She served as an editorial assistant to the late George Dimitroff. She was instrumental to the continued publication of the ***Quarterly*** following his death. At the time of her death, she was employed in the Directorate of Operations and Maintenance (DEMM), HQ Air Force Engineering and Services. She is survived by her husband, Walter D. (Don) McDaniel, an industrial engineer with AFESC/DEMG. The family requests that in lieu of flowers, donations be made to the American Cancer Society.

HONORED

Jamusz S. Przemieniecki, Senior Dean of the Air Force Institute of Technology and dean of the School of Engineering, Wright-Patterson AFB, Ohio, was awarded Distinguished Executive Rank by President Ronald Reagan.

Also recognized and awarded the Senior Executive Service Bonus was **Mr. Harry P. Rietman,** associate director Air Force Engineering and Services.

SAF/MII REORGANIZED

The Office of the Assistant Secretary, Deputy Assistant Secretary (Installation, Environment and Safety) has been reorganized. The new list for individuals, locations and telephone extensions within the Pentagon is now:

James F. Boatright, Deputy Assistant Secretary (EI&S)—4C940—53592

John O. Rittenhouse, Deputy for Installations Management—4C940—77244

Deputy for Facility Programs (vacant)—4C940—77244

Andrew A. Johnston, Assistant for Construction Programs and Facility Maintenance—4C940—77003

Lt. Col. Anthony Pyrz, Assistant for Engineering and Construction—4C940—77070

Assistant for Environment and Safety (vacant)—4C916—70800

Col. Sherrill G. Laney, Assistant for Occupational Safety and Health—4C916—79297

Lt. Col. Peter S. Daley, Assistant for Environmental Quality—4C916—79297.

SAC NCOs: Professionals Worth Noting

Each year, nine Strategic Air Command missile wings and their support units gather at Vandenberg AFB, Calif., to compete for honors in the Missile Combat Competition. Civil Engineering technicians representing SAC, Military Airlift Command and Tactical Air Command have been competitors for the past seven years. Each provides direct missile maintenance support for the Titan II and Minuteman weapon systems.

Preparation for the next Missile Combat Competition begins soon after completion of the annual event. The 3901st Strategic Missile Evaluation Squadron conducts most of the competition events. But, the Civil Engineering activity is planned, programmed and conducted by two Non-Commissioned Officers on the staff of the SAC Deputy Chief of Staff Engineering and Services.

SMSgt. Charles Hightower and **Msgt. Thomas Cade** spend hundreds of hours identifying maintenance tasks and preparing for a competition that accurately represents the maintenance support effort provided by BCE technicians at three Titan and six Minuteman units. After task identification, the equipment is prepared in the evaluation environment, programmed modifications or deficiencies are put into the script and a baseline time for completing the task is established. All of the logistical support required for the competition is also managed by Sergeants Hightower and Cade.

During the competition week, they become the chief evaluators, objectively scoring each exercise and selecting the best BCE missile support technicians for each weapon system. Missile support quality control and training managers assigned to the Directorate of Missile Facilities, DSC Engineering and Services at SAC Headquarters, they are both key members of the SAC Civil Engineering Missile Assistance Team which travels to each missile unit in an advisory capacity. While at home at Offutt AFB, both NCOs are committed to developing new procedures for management and maintenance of ICBM real property and real property investment equipment. Their evaluation of modification proposals and their recommended resolutions for hardware deficiencies are always top notch.

SMSgt Charles Hightower and MSgt Thomas Cade are two professional NCOs worthy of note according to George R. Rasmussen, Deputy Director, Programs, SAC/DEP.

HIGHEST DEGREE OF EXCELLENCE LAUDED

Major Gen. Clifton D. Wright, director, U.S. Air Force Engineering and Services, recently presented the Military Airlift Command Golden Door Plaque to **Col. Larry McGovern,** 435th Combat Support Group Base Civil Engineer. The award was given to Colonel McGovern at the MAC Engineering and Services Conference Oct. 6.

The award is presented annually to the military family housing management office achieving the highest degree of excellence in management and customer service for the period of July 1 through June 30 of the preceeding year.

AFIT SCORES ANOTHER FIRST

Master of Science in Engineering Management (MSEM) degrees were conferred Sept. 29 upon the civil engineering officers of the 1982S School of Systems and Logistics (SOSL) graduating class.

The graduating students received an Accreditation Board for Engineering and Technology (ABET) accredited MSEM degree.

AFIT's SOSL at Wright-Patterson AFB is the first graduate-level institution in the country to award the ABET accredited MSEM.

Class honors went to Capt. Steven Lofgren, who received the Society of American Military Engineers Award for his selection as the top Graduate Engineering Management (GEM) student. Capt. Thomas McDonald and Capt. Robbin Schellhous were each awarded "Pride-in-Excellence" awards for their outstanding thesis reports. Only six of 147 graduating students received "Pride-in-Excellence" awards. (AFIT/LSM, Major Alan E.M. Tucker, AUTOVON 785-5023)

Front row (l to r): 1Lt. Christopher Basham, Capt. Randall Bunner*, 1Lt. William R. Burcher, Capt. Richard C. Howell, Capt. Schellhous, Maj. Tucker (Program Manager), Second row: Capt. Robert Peters, Capt. Steven Waller, Capt. James Rish, 1Lt. Larry Lawrence*, Capt. Lofgren*, Capt. Michael Dronen, 1Lt. Kevin Donnelly, Third row: Capt. Ken Stoner, 1Lt. Martin Duke, Capt. Michael Clayton, Capt. William Floyd*, Maj. Harold Mercer (USMC), 2Lt. Charles Smiley; Fourth row: Capt. McDonald*, Capt. Linden Torchia, 2Lt. Stuart Hartford*, Capt. Roger Sunada, 1Lt. William Merrill, Capt. Michael Darnell, and Capt. James Baughman (*Distinguished graduate).

SMSgt. Charles Hightower and MSgt. Thomas Cade.

One of the key addresses before the Air Force Engineering and Services Design Symposium was by Col. Sydney E. Key (USAF, Ret.), who is credited with a consistent program encouraging design excellence while director of the Air Force Regional Civil Engineering Office, Central Region, Dallas, Tex., from 1973 to 1978. Since his retirement he has been in private practice in Arlington. He is a registered architect in Texas and an architectural graduate of the University of Texas. Since retirement he has earned design awards from the Texas Society of Architects and from the Interdenominational Council of Church Architecture in New York.

Design Excellence: *How to Achieve It*

By Sydney E. Key (Colonel, USAF, Ret.)

There are few in the Air Force who have more long range impact on the physical environment of our Air Force installations than those who are involved in acquisition of facilities. But there is a tendency among those "Designers of Buildings" to overlook the permanence of the structures they help to create.

Many of our installations have structures built more than 50 years ago, some with structures built over one hundred years ago, and still a vital part of our physical plant. How well we must appreciate the efforts of past generations of designers for their efforts to leave us with structures that continue to serve a useful function and add desirable character to our installations. These well-designed buildings are in stark contrast to those buildings built over the years that were poorly funded, poorly designed and constructed. Once built, these poorly designed buildings remain a part of our "permanent" inventory. We must remember that what we build today will most assuredly outlive us all.

And it is you who are actively involved in facility acquisition who must continue to strive for design excellence of every facility in every way you can. Because you are here, we know you have a role to play. It is how you play that role in your assigned capacity; it is your determination, expertise, ability to communicate, timeliness, and leadership that will assure a continuing improvement in the quality of design of Air Force facilities.

It is heartening to see more and more new buildings reflecting design excellence. This is a testament to your efforts and the efforts of the multitudes involved in programming, planning, designing, constructing and maintaining our facilities and their environs. But there are still too many poor examples being built. Some can't be helped, but many could have been.

Excellence in design is rarely easy. It must be pursued with vigor and determination. Everyone involved must be aware of the necessity to give their utmost contribution. The pitfalls and obstacles must be avoided or overcome if excellence is to be achieved by design rather than by accident.

We have experienced many obstacles and stumbling blocks in our quest for design excellence, and each of us, in our given role, has pursued a path that led to one example or more of design excellence that has been recognized by our peers

Design Excellence—too many people relate this term to appearance. Unfortunately this includes some architects. But, in my opinion, design excellence is the total. It is all-encompassing, the whole thing—a structure and its environs. Appearance is certainly one very visible requirement. The structure should be pleasant and appealing, acceptable to the majority, and with lasting appeal. Architecture, like art and sculpture, must continue to appeal, it must retain a lasting quality. Permanence in design beauty is as important as permanence in construction materials. Later generations view such a structure with admiration and strive harder to keep such buildings in good repair. As a result, use of these buildings continues to be desirable, and those well designed buildings will continue to serve useful functions, while poorly designed buildings will become a blot, undesirable to the users, and ultimately will be torn down and replaced. This costs our government more money in the long run

But aside from appearance, there are many other aspects of design excellence. Functional planning, flexibility in use, consideration for expansion, general atmosphere generated, and exterior environs must all be considered and appropriately handled. Adaptability, although not part of the criteria generally given, should nevertheless be a consideration of the concerned architect, and even more so by those who must approve the design. But good functional design is a paramount consideration. And this factor starts with the base, or user of the facility. All too frequently, the user develops his own plan with little expertise in planning. His total experience may be the one building he is presently using and he just wants to assure he does not have the same problems. He therefore locks in a plan with other built-in defects. By the time other echelons have stamped their approval on this plan, the professional designer—the one who could best provide a truly good functional plan—is restricted to making the most of the plan provided. What a waste of talent and opportunity! The base civil engineering personnel also contribute to this dilemma in many instances for various reasons, but one of the poorest reasons is their excuse to "not make waves."

I fully realize the politics surrounding base activities, but an architect or engineer on the civil engineering staff should be able to convince those involved of the merits of getting professional help in the functional design of a building. We pay for that professional expertise! We should take full advantage of it. I admit that many architect-engineering firms, especially those who had been designing for the Department of Defense for many years, are so embued with the attitude "follow the plan given" that they make little of the effort that they should to develop the project into one of excellence. And there are others who are so remotely familiar with the prescribed functions of a building, they will take the easy way without making the studies necessary to become thoroughly familiar with the requirements.

Our project booklets have been a real boon to architectural excellence, and when properly prepared, have given the designers much of the information they need. What we must do is assure the designers are aware of our desire for design excellence, and insist on their professional contribution. This was a major effort while I was at the AFRCE at Dallas, and the results were outstanding. So it can be done! And is being done in the AFRCE.

The time frames required for design completion constitute perhaps the most damaging factor to obtaining outstanding design. This problem faces all those involved from initiation of

AIR FORCE DESIGN EXCELLENCE individual award is presented to architect Sydney E. Key (Col. USAF, Ret.) of Arlington, Tex., by William A. Brown Sr., chief of the Architectural and Engineering Branch, HQ USAF/LEEES. also honored were Maj. Gen. Robert E. Kelley, superintendant of the U.S. Air Force Academy; Maj. Gen. William D. Gilbert, past Director, Air Force Engineering and Services; Gary Lynn, architect, Air Force Regional Civil Engineering Office, Central Region, Dallas, Tex., and Mr. Brown.

the project to the completion of design. It has been my experience that if all the information has been properly compiled at every step, there is always adequate time. But the interest of many people involved lays dormant until they realize the project is about ready to start construction. The users generally see little to get excited about in the early stages, as more than likely, the facility will be constructed long after they have left their present assignment. Timeliness, salesmanship, leadership, and communication are factors that can be employed by the base civil engineering personnel to overcome this obstacle.

Architect-engineer selection is another major effort to be concerned about. I have found that all too many members of a selection board are more apt to vote for a firm they have heard of rather than make a detailed analysis of the firm's capability. Many times that results in big, well-known firms getting jobs that are really insignificant to them, and relegated to the third, fourth, or tenth level design teams. The best results I have encountered started with selection of an A-E firm which prized their selection – the project represented their major effort. A small firm for a small job will generally put their best effort on a job that means something to them. It is very important that the firm selected should have demonstrated their design talents within the accepted parameters of the Air Force. Extreme design only causes delays, redesign, cost overruns, etc., so pick your partners in design with care! And you must convince the other board members of the significance of what they are doing. Quietness is not a virture when sitting on an A-E selection board. If you have done your homework, you will have identified three firms that will be the best selection. With salesmanship, one of those three will be selected. To try to sell only one firm creates an aura of doubt and refusal by other board members. So play it smart! There are always at least three good firms to do the job. Just make sure you get one of them!

And never let pass any meeting with anyone working on the project that you do not discuss design excellence. You will find it will become contagious if you are doing your job. Some of the project engineers in the AFRCE were skeptical that this would do any good when we first started this effort, but they became staunch advocates of "preaching" design excellence as they saw the results we were obtaining. We had shown them it could be done, and how to do it.

It takes all of us, from the initiation of a project to its completion, to achieve design excellence – and communication, timeliness, salesmanship, expertise, and persistence are key words in the process.

E&S

Hill AFB Wins DOD Award

Hill AFB, Utah has won the Secretary of Defense Environmental Quality Award for 1981. Secretary of Defense Caspar W. Weinberger presented the award at the base to Maj. Gen. Leo Marquez, commander of Hill's parent command, Ogden Air Logistics Center.

Hill was the Air Force's nomination for the Department of Defense Environmental Quality Award following the receipt of Air Force's Thomas D. White award. The awards recognize that Hill conducted the best environmental quality program during 1981.

The base was specifically recognized for its efforts in the areas of resource conservation and recycling, solid waste management and hazardous waste management.

Within the past 15 months, Hill has made many improvements in its resource conservation measures. Energy conservation efforts reduced fossil fuel consumption by 17 percent from 1980 and by 19 percent from 1981.

Last year, the paper recycling program recovered more than 1,000 tons of waste paper, double the amount from 1980. The paper was sold for a profit of $40,000 and the money was used to help pay for other base projects and activities. Oil consumption decreased by 14,000 barrels.

Hill's solid waste management program includes the paper recycling program, a new petroleum recovery plan, and a joint project with a local planning council to develop a refuse incinerator to produce steam and electricity. Refuse from the base and the local area will be burned to produce energy which will be offered to the base.

With the fuel recovery plan, the base is reusing more of its aviation and motor fuels instead of selling them. The reuse value is higher than its sale value. Most of the material will be reissued for use as a heating plant fuel. By the end of 1982, Hill hopes to reuse 40,000 gallons of petroleum.

The award also recognizes Hill for its management of hazardous and toxic materials required in its maintenance and repair activities. Several management programs track their use and monitor their collection, storage and disposal.

More than 7,000 line items are marked with a coding system for special training or handling requirements. Another system monitors work place environments to determine their effect on employees' health.

Hill also operates a complex, chemical sensing system in one of its depot repair shops. The only one of its kind in the Air Force, the system measures concentrations of ten chemical gases as part of an employee health protection plan.

Hill's hazardous waste disposal operation includes landfilling and burning or detonation of munitions and missiles. Solid hazardous waste includes treatment plant sludges, foam-type aircraft fuel tank liners, sand blast media, and waste products from the machining of heavy metals.

Five special response teams have been organized to respond to aircraft missile component and depot emergencies. A specialized hazardous material contingency team is available for worldwide deployment, since Hill is responsible on a worldwide basis for most Air Force related explosives munitions and solid propellants. In addition, Hill operates a hotline to report spills of any kind.

Birds, grasshoppers, mosquitos and weeds are hazards to base duties too. Hill's pest management program is aimed at controlling or ridding the base of these problems so they won't interfere with flights or munitions and missile test targets. Test areas are kept clear for photography and analysis purposes.

Hill is the only Utah industry with a program to restore hazardous waste sites to safe operating conditions. The program concentrates on older sites that have developed environmental problems.

Hill's competitors for the award included Army and Navy bases in Virginia and Maryland.

E&S

Your Exchange In The 21st Century

by Capt. Sue Leonard, USAF
Army and Air Force
Exchange Service,
Public Affairs Office

Motion pictures from space, shopping via television, automatic electronic payments and gourmet meals from vending machines are all part of the Army and Air Force Exchange Service (AAFES) of 2000.

AAFES motion picture theaters may look the same in year 2000 but there will be significant changes. Movies will be transmitted to the theater via satellite. This will not only permit more frequent changes but will achieve enhanced picture quality and Dolby three dimensional sound.

State-of-the-art food facilities will also be a part of the AAFES family. With new technology coming on-line daily, customers may be able to go to their nearest AAFES Vending Bank, drop in a few coins and receive a full course meal — Trout Almandine, Duck a'Orange, or Lobster Newberg, All they will have to do is pop the package into a waiting microwave oven — instant dinner. The food may have been prepared at a central kitchen in Texas with complete portion control — a certain amount of mashed potatoes, a specific number of peas and a carefully weighed and cut main dish — all calculated by master chefs to be hot and done to taste at the same instant.

New products on the market already are formulated so no freezing or chilling is necessary — milk which has a six month shelf life without refrigeration; bread which can remain in one's pantry for over a year, etc.

Customers will probably not be aware of most of the changes their exchanges will will undergo by the year 2000 but they will benefit from them.

The most noticeable change will be in the physical structuire of the exchanges themselves with emphasis on energy conservation. Since the mid-70s, new exchanges have had fewer entrances, more efficient equipment to reduce replacement frequency and computer-controlled lighting, temperature and security systems. This trend will be accelerated as new or replacement exchanges are approved. As for alternative energy sources, if the cost of solar energy comes down or Federal governmental subsidies are restored, solar energy will be installed where cost effective.

The computer will continue to be a most useful tool in AAFES' stores. Plans, specifications, installation demographics and projections will be programmed in to help calculate design plans and specifications. Building costs should decrease as the computer's ability to duplicate designs required to meet size differences, energy saving programs, environmental needs and internal layout concepts increase. Engineers will be free to be responsive to local installation design concepts, restrictions, modifications or design of new types of facilities.

Use of computer-design capabilities will not mean all exchanges will look alike. As is the case now, some installations have concentrated populations and the space for large shopping malls while others are spread out over wide areas and require separate exchange facilities to meet their needs. This practice — fitting the exchange to the needs of the installation — will continue in the future.

Inside the store, customer service and convenience will keep pace with state of the art retailing practices. In some cases, AAFES exchanges will be leaders.

Currently, AAFES is conducting a test of a point-of-sale (POS) scanning checkout system that is compatible with what major retailers are implementing at an increasing rate annually. The system allows customers to check out their purchases faster through the scanning of the Universal Product Code (UPC) imprinted on the item by the manufacturer. Obviously, scanning is on its way; and it's not only going to be a boon to the retailer in terms of improving their operations, it's also going to provide the best source of marketing information ever available. This will enable retailers to offer the best assortment of merchandise to satisfy customer needs.

Video discs, videotapes and computers will be availabe in most exchange departments where customers can see the latest fashions, get instructions on how to plan and plant a garden, use a new tool or trouble-shoot their electrical appliances. Discs and tapes will probably be available on a wide assortment of subjects for customer checkout so a project .can be followed step-by-step.

There are also plans to put the exchange catalog on videodisc. Customers will be able to check out discs and phone their choices directly to a computer terminal which will not only place their order but handle payments as well.

The changes foreseen by year 2000 will not be radical ones — they'll evolve gradually over a period of time. So gradually that there will be little perception there has been a change.

So in year 2000, AAFES customers will probably still shop the exchange for their lawn mowers, their clothes, their fuel and their food but with differences. The exchange may also supply travel, and some legal, medical and dental services and veterinary care for pets. The one-stop shopping center may include investment and insurance brokers, CPAs to help on tax problems — the complete range of activities and services to make life in the military more closely allied with civilian life.

To those of us not personally acquainted with the workings of the computer or video games, things will be different in year 2000; for our children, it will be just the normal way of life. After all, our great grandparents didn't have jet planes or monorails, televisions or electrical appliances and today these things are common.

E&S

THE WURTSMITH TEST:

Aeration Strips Contamination From Groundwater

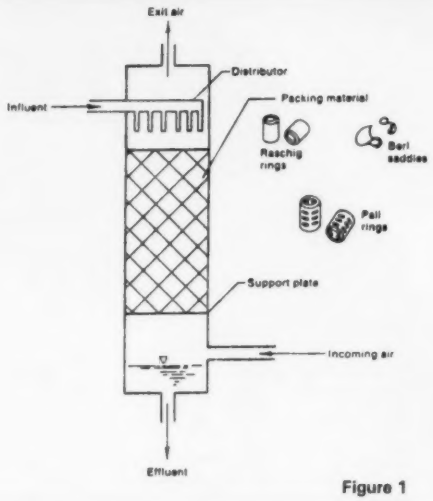


Figure 1

by Maj. Stephen G. TerMaath

Only in the last decade has the scientific community recognized the ease with which organic solvents migrate into groundwater. Previously, spills, storage of spent solvents in unlined lagoons and other discharges on the ground were not considered environmentally significant. It is now known that even small household discharges to septic tanks have resulted in major groundwater contamination. The Air Force, like civilian industry, uses large volumes of solvents and, while its past actions were in consonance with environmental regulations, groundwater contamination did occur.

Discovery of trichloroethylene (TCE) in drinking water at two installations in the mid 1970s alerted the Air Force to its first cases of contaminated groundwater. In both cases, the installations are dependent on groundwater for a water supply. Nearly every Air Force installation relies on groundwater as a primary water supply or a backup supply if civilian sources are interrupted. More than 10 installations are now reporting contaminated groundwater. The Air Force, through its Installation Restoration Program (IRP), is investigating past chemical usage and disposal data to determine the potential for contaminated sites. If a high potential exists, site monitoring is performed to establish if contamination has occurred. In those instances where significant contamination is confirmed, containment and cleanup methodologies are pursued.

Sources of Contamination

Sources of contamination are varied and reflect actions that were once considered inconsequential. Sources include: burial of waste chemicals in sanitary landfills; spills of fuel and solvent; disposal of waste chemicals in clay-lined or unlined evaporation lagoons; leakage from underground storage tanks; and seepage from unlined diked areas around fuel storage tanks. Even though new approaches are being followed to eliminate sources of contamination, extremely small releases will continue to play a major role in contamination of groundwater. For example, one contaminate plume extending three fourths of a mile resulted from 50 to 100 gallons of trichloroethylene (TCE) entering a groundwater aquifer about 15 years prior to discovery. The probable source is either one or a series of spills near an Air Force maintenance facility. Until recent years TCE, a common Air Force solvent, was the major ingredient in septic tank cleaners for intentional discharge to the subsurface.

Response Actions

Once contaminated groundwater is discovered, no direct approach exists for identifying the extent of contamination or the optimum alternative for corrective action. Confirmation and delineation is obviously complicated by geological conditions and the three dimensional boundaries of a contaminate plume. At best, monitoring wells only provide a vertical distribution of concentration at a single location. Consequently, numerous wells, chemical analyses and data analysis lead to investigative costs in the range of $200,000 to $800,000. After the extent and level of contamination is known, the next hurdle is determining an allowable concentration in both the groundwater aquifer and water pumped to the surface for drinking water. Acceptable concentrations of organic chemicals in drinking water are available for only a few chemicals. Thus, federal, state, and local regulatory agencies must establish a limit. Since these limits are usually in the part per billion (ppb) range (a ppb is equivalent to 1 drop of vermouth in 84,000 quarts of gin), amortized capital and operational costs for containment and treatment at an Air Force installation will ***start*** at $200,000 per year with accepted technology.

Assessing the extent of contamination in a groundwater aquifer is only the beginning of a costly path toward corrective action. Responses to contamination can be of three types. First, no cleanup or treatment—stop using contaminated wells, and use other existing wells or develop new sources outside the contaminated area. Second, continue to withdraw contaminated groundwater and treat it before use. The third approach is to prevent further movement of contamination in conjunction with a program to restore the groundwater. Each type of response can be defended under the right circumstances. The last approach is sure to be accepted by regulatory agencies and is the most costly, but one of the other approaches may still provide sufficient protection of the environment. Unfortunately, the methods do not exist for accurately evaluating and comparing the impact of the three responses.

Until safe levels of organics are determined and the fate of organics in groundwater is better understood, treatment systems will probably be required at each installation where contaminated groundwater is discovered.

The final step in a response action is

usually the installation of a containment and/or treatment system. Activated carbon was once the only treatment system with sufficient removal efficiency. However, typical one-million-gallon-per-day (700 gpm) system costs about $1.5 million and has an annual operating cost of about $400,000. The Strategic Air Command recognized that these costs are too high and, in 1979, asked the Air Force Engineering and Services Laboratory at AFESC to develop a more cost effective treatment process.

Air Stripping

An initial review of potential alternatives to activated carbon revealed that on a theoretical basis, air stripping had the potential for high efficiency removal at a much lower cost. Air stripping involves bringing air and water into contact for the purpose of transferring an organic contaminant from the water. Literature reported success with air stripping in limited applications. The process was essentially unproven for low concentrations of chlorinated organics such as TCE.

Only organic compounds with a favorable Henry's constant are ameanable to air stripping. The importance of Henry's constant is evident in the basic equation:

$$H = C/P$$

Where H is Henry's constant of the compound, P is a measure of the concentration in the gas phase, and C is the concentration in the liquid phase. The relationship applies to equilibrium conditions for an air volume in contact with the water. The greater the Henry's constant, the greater the affinity of the organic for the gas phase compared to the liquid phase.

Two types of air stripping for consideration include:

(1) Diffused aeration, bubbling air up through water and

(2) Countercurrent packed columns (Figure 1) with a downward water flow over a packing material and an upward flow of air.

The Environmental Protection Agency and other civilian groups had investigated diffused aeration and were recommending it as removal process. The process was considered in cases where contamination was very low, and the required removal efficiencies were on the order of 50-85 percent. Diffused aeration provides less interfacial area and generally less efficient transfer of the organic from the water to the air compared to packed columns. Packed columns provide high liquid film areas compared to the liquid volume and permit high air-to-water ratios.

Packed columns were chosen for study at the Engineering and Services Laboratory because of the potentially higher efficiency and similar costs compared to diffused aeration. Although packed columns and the equations to describe their performance were available, they had not been used for water treatment to supply a discharge with organics in the low parts-per-billion range. Henry's constant and mass transfer rates were either unverified or unknown for the extremely low concentrations required for drinking water. This information is critical to evaluating the size, cost and complexity of packed tower air stripping.

Lab Studies

The first step began with a determination of Henry's constant for TCE since highly variable values were reported in the literature. The effects of parameters such as temperature and total dissolved solids were also needed to evaluate air stripping

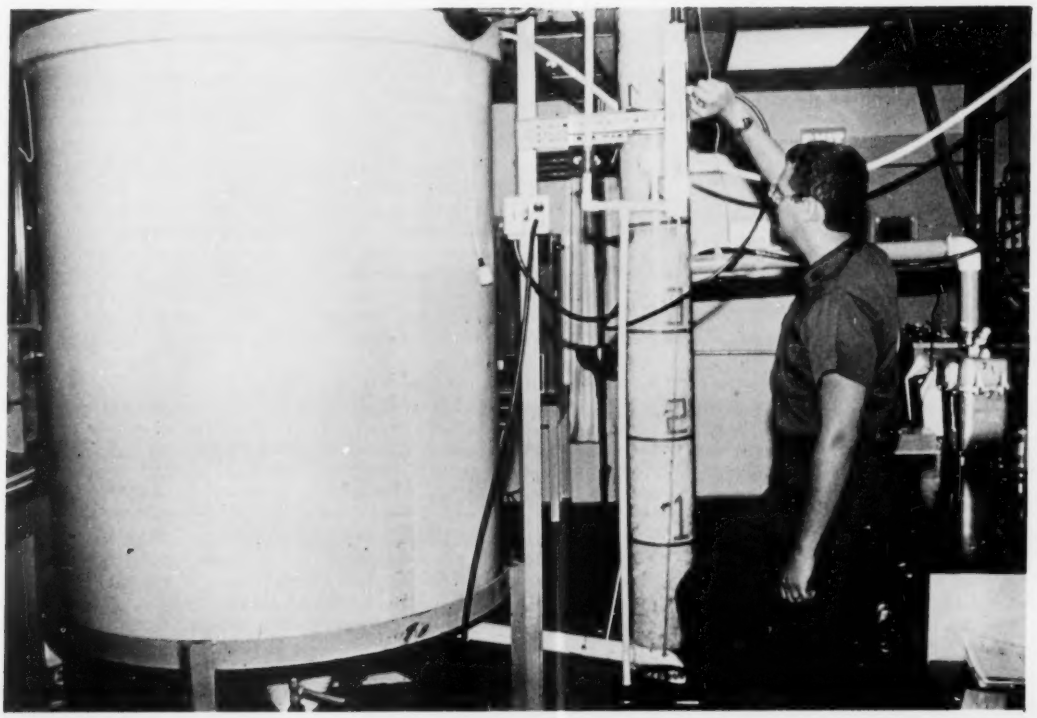


Figure 2

applicability in different climates and with different groundwaters. As expected, Henry's constant showed a strong dependence on temperature with the value doubling for an increase from 10 to 25°C. The effect of total dissolved solids on Henry's constant was of no practical significance over the range typically encountered in groundwater.[1]

The Henry's constant was then used in determining the overall mass transfer coefficient, K_La. While the Henry's constant indicates the amount of organic that can be transferred to the air, the mass transfer coefficient provides the rate. The K_La reflects physical and operational features of a packed tower. The parameters affecting K_La include temperature, type and size of packing, and turbulence (controlled by the air and water flow rates).

The countercurrent flow packed column for determining the mass transfer coefficient in the laboratory is shown in Figure 2. The large storage tank on the left was used to prepare known concentrations of TCE in water. Water was pumped from the storage tank to the top of the eight-inch diameter packed column at rates up to 9.5 gallons-per-minute. The column contained up to nine feet of 5/8-inch Pall rings. Sample ports on the column allowed collection of liquid at about one foot intervals. Liquid and air temperatures were varied in the range of 10 to 30°C.

Analysis of the laboratory data provided the value for the mass transfer coefficient and the means to design a full scale packed column. Combining the actual efficiencies obtained in the laboratory and equations for packed column performance, graphs for determining the volume of packing were developed. An example graph is shown in Figure 3 where:

- G/L is the volume to volume ratio of the gas (air) and liquid (water) flows
- L is the liquid flow rate
- Z_T is the depth of packing
- and A is the cross section area of the packed column.

Figure 3 is for use with air and water temperatures at 10°C. The temperature dependence of both the Henry's constant and mass transfer coefficient makes graphs at various temperatures necessary. Note that a family of curves is presented because removal efficiency is dependent on the air to water ratios up to a limit. Increasing the air to water ratio produces diminishing improvement as the maximum rate of transfer from the water to the air is reached. Selection of an air to water ratio is a trade off between operation costs of high air flows and capital costs for larger columns at low air-to-water ratios.

A graph such as Figure 3 can be used in the first step to design a packed column. Using the desired removal efficiency, a value for Z_TA/L is determined from the graph. This value multiplied by the water flow rate to be treated yields the required volume of packing material. Final selection of the packing height and cross section are dependent on standard column diameters and allowable hydraulic loading factors for the packing material.

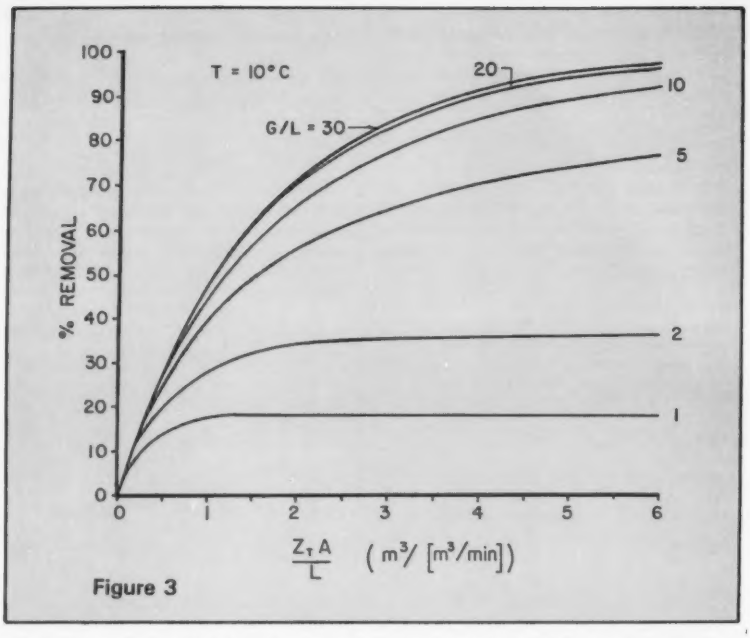


Figure 3

Full Scale Demonstration

The decision to proceed with a full scale packed tower air stripper was based on the laboratory studies which demonstrated the feasibility of high efficiency removal of TCE from water. Operation of large scale packed columns had not been documented in the literature. The ability to scale up findings from a 10 gpm laboratory unit to full scale had to be confirmed. In addition, operational problems had to be identified before recommending the process to Air Force installations.

Wurtsmith AFB, Mich., was selected for the full scale demonstration because it could provide a dual function:

(1) Provide lower treatment costs during groundwater cleanup operations there and

(2) Test the performance of a full scale unit.

The harsh Michigan winters will stress the design performance and maintenance of the packed tower system. A system with two packed columns was chosen to give the flexibility of the columns in parallel or two columns in series (see Figure 4). The design was for 1,200 gpm (1.75 million gallons per-day) in parallel operations or 600 gpm when in series. The design efficiency was 90 percent removal of TCE during worst case winter conditions. The design (based on the laboratory studies) and construction costs totaled $185,000.

The carbon columns referenced in Figure 4 are a polishing step to remove TCE in the effluent from the air stripper and are required to meet a discharge requirement in Michigan of essentially nondetectable (less than 1.5 ppb) TCE. Even with activated carbon treatment, the packed towers will reduce operating costs by up to $200,000 per year. The air stripper columns remove TCE which would otherwise be adsorbed on the activated carbon; thus, significantly reducing the cost of replacing the carbon. The cost of the air strippers is offset by just one year of reduced operating costs for the activated carbon system.

The air strippers went into operation in May of 1982 (See Figure 5). The two columns are five feet in diameter and 35 feet high. The packed bed contains 5/8-inch Pall rings at a depth of 18 feet. Representative performance data from tests in May and August are given in Table 1. The removal efficiency is presented as a percentage of the influent concentration. The testing also confirmed the theoretical equations which show removal efficiency is independent of the influent concentration. The results confirmed the high removal efficiencies possible with air stripping. However, the final evaluation will not be completed until after winter testing in January 1983.

The overall operation has been very good, and some operational lessons have been learned. Precipitation of dissolved solids can be a problem with some ground-

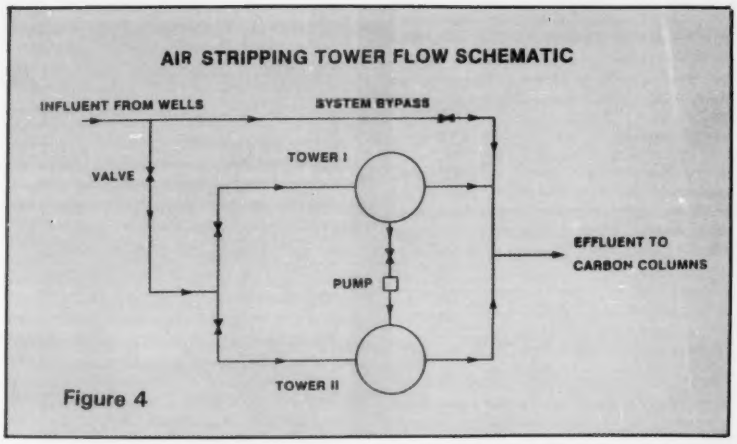


Figure 4

waters but chemical treatment can prevent precipitation in most cases. Although the water at Wurtsmith had potential for calcium and magnesium precipitation, laboratory tests were negative, and no deposition of solids has occurred in the air stripper. An unexpected bacterial growth did develop in the air stripper. A heavy growth was discovered on the packing when investigating the cause of decreased air flow through the air strippers. Eight different organisms were identified before the packing material was cleaned. This diverse bacterial growth in groundwater is rare and unexplained. Periodic addition of chlorine to the influent was begun to prevent future growth. Since TCE is essentially non-biodegradable, no other food source for bacteria has been identified in the water.

The question of air pollution is often raised in a discussion of air stripping. The potential for air pollution is low since treatment of 1,200 ppb of TCE in one million gallons per day would only release one gallon of TCE. In addition, the concentration of TCE in the exhaust air is normally so low that the air meets criteria for human occupational exposure. Discharge permits for the exhaust air can be obtained in nearly every state. If the organic cannot be discharged, air treatment can be added. The overall treatment cost of air stripping with air treatment is still less than the cost of treating the water with activated carbon.

Summary

Packed tower air stripping is a viable alternative to activated carbon for removing volatile organic compounds. Ongoing studies will provide the baseline data needed for evaluating the application and efficiency of air stripping in individual cases. The final chapter on air stripping is not written yet, but the performance to date is excellent. Efficiencies in excess of 99.9 percent were measured for trichloroethylene (TCE). The ongoing work will expand our knowledge of the ability of an air stripper to treat volatile organic compounds other than TCE, e.g., dichlorothylene and methylene chloride. Research is also underway to investigate the simultaneous removal of multiple organics and their effect on removal of each other. In the meantime, the Air Force can begin plans for using the air stripping technology for treatment of groundwater contaminated with TCE and other volatile organics.

Packed tower air stripping is not ***the*** answer to Air Force problems with contaminated groundwater, rather it is only one part of comprehensive development program to provide Air Force engineers with the tools to address incidents of contaminated groundwater. These tools being developed include:

- Basic chemical parameters on adsorption and desorption of contaminants on soil
- Chemical and biological degradation in the aquifer
- On-site capability for rapid chemical analyses to monitor treatment processes
- And a means to predict the movement of contaminants in the groundwater aquifer with and without containment actions such as pumping.

A report detailing state-of-the-art technologies and data for responding to incidents of contaminated groundwater will be distributed early in 1983. This is just the first step in the Engineering and Services Laboratory program to transfer new knowledge and technology for more efficient and cost effective methodologies for answering issues on contaminated groundwater. E&S

Reference

1. Gossett, James M., "Packed Tower Air Stripping of Trichloroethylene from Dilute Aqueous Solution," ***1980 USAF-SCEEE Summer Facility Research Program,*** September, 1980.

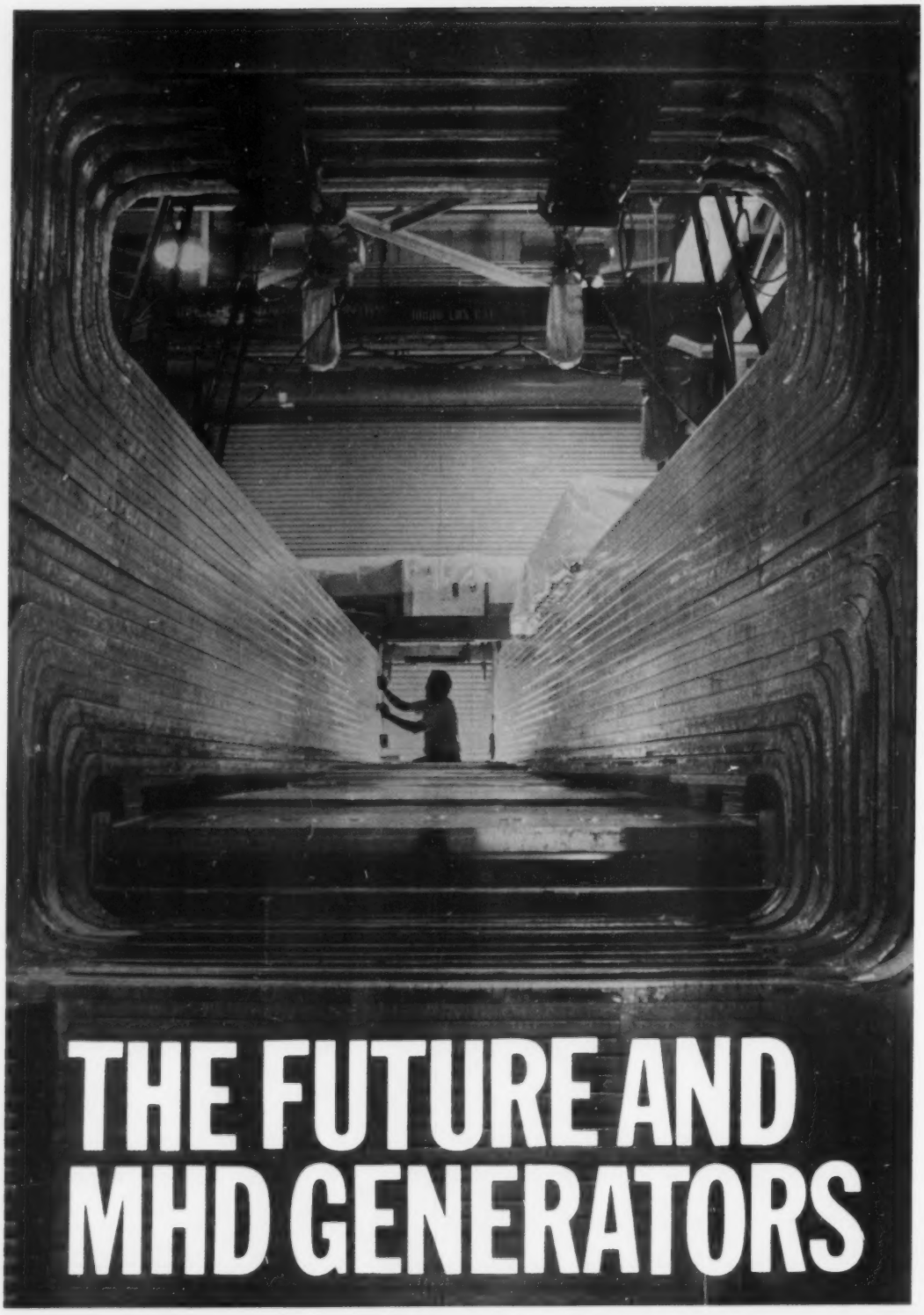
PERFORMANCE OF PACKED TOWER AIR STRIPPERS—WURTSMITH AFB, MICH.

Air to Water (vol:vol)	Water Flow GPM	Efficiency Single Tower (% Removal)	Efficiency Series Operation (% Removal)
10:1	300	95	99.8
10:1	450	94	99.8
10:1	600	86	96.0
18:1	300	98	99.9
18:1	450	97	99.9
18:1	600	90	99.7
25:1	300	98	99.9
25:1	450	98	99.9
25:1	600	98	99.9

NOTE: Influent water had TCE concentrations of 50-8000 ppb and a temperature of 11 °C.

Table 1

Figure 5



THE FUTURE AND MHD GENERATORS

by Deborah W. Stirling
Manager, Public Affairs, Arvin/Calspan

March 21, 2000—Another step toward reduced energy cost was taken today as the Tactical Air Command Air Force Base power plant was converted to a magnetohydrodynamic (MHD) direct energy conversion process.

This culminates over half a century of development work on the MHD conversion process in keeping with the national goal to make all strategic and tactical military bases independent of commercial power systems.

A significant step in this development process was taken when the High Performance Demonstration Experiment (HPDE) was carried out back in the early 1980's at the Air Force's Arnold Engineering Development Center (AEDC) near Tullahoma, Tenn.

The preceeding account could foreshadow the future if the development of MHD proceeds on schedule. A national program has been underway since the early 1970's to develop MHD as a viable energy conversion alternative, with a goal of demonstrating that the MHD process is not only technically feasible but economically attractive.

Most researchers now agree that a pilot demonstration plant consisting of an MHD topping cycle and a conventional steam bottoming cycle could be "on line" by the mid-1990's. The first generation of this type of power plant will probably be similar to that shown in Fig. 1.

In the combined cycle, pulverized coal is burned in a high pressure cyclone combustor with oxygen-enriched air. The resulting plasma is then passed through the MHD generator channel, where a portion of the energy is converted to electric power. The plasma then exits the MHD device with sufficient thermal energy remaining to drive a conventional steam plant.

Extensive research and development yet remain before a pilot plant can become reality, but before launching into detailed technical discussion, some historical background and discussion of the basic principle of MHD might be useful.

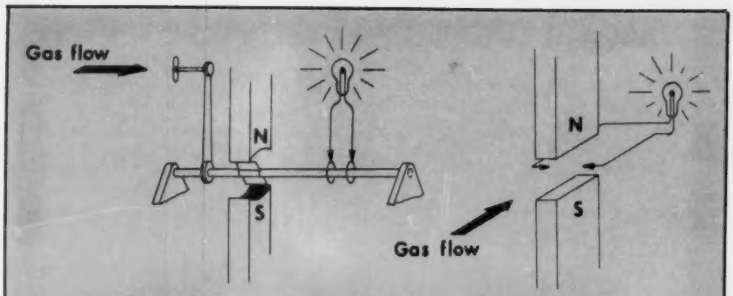


Figure 2: Electric power generators.

MHD—The Basics Explained

The basic principle involved in generation of electricity is that when a conductor is used to cut magnetic field lines an electomotive force (emf) is induced in the conductor. If suitable connection is made to an external load, a current will flow and power is produced.

In the case of a conventional turbine generator, the energy of a flowing gas is used to drive the turbine which then drives a rotating electric generator (see Fig. 2). The solid conductors in the armature of the generator cut the imposed magnetic field lines.

When the external load is connected (shown as a light bulb in Fig. 2), power is generated. Since the shaft is rotating, brushes are required to make this connection. In an MHD generator, the flowing gas is itself the conductor and flows through the magnetic field (Fig. 2). Current is drawn directly from the gas by electrodes which are connected to an external load. In an MHD generator, then, there are no moving metal components thereby eliminating the close tolerance requirements common to other high temperature devices such as rotating steam turbines.

The history of magnetohydrodynamics dates back to 1832 when Michael Faraday performed an experiment in the Thames River in England. He was able to detect an emf between two electrodes submerged in the river. The saline water of the river, although a relatively poor electrical conductor, cut the earth's magnetic field lines as it flowed along.

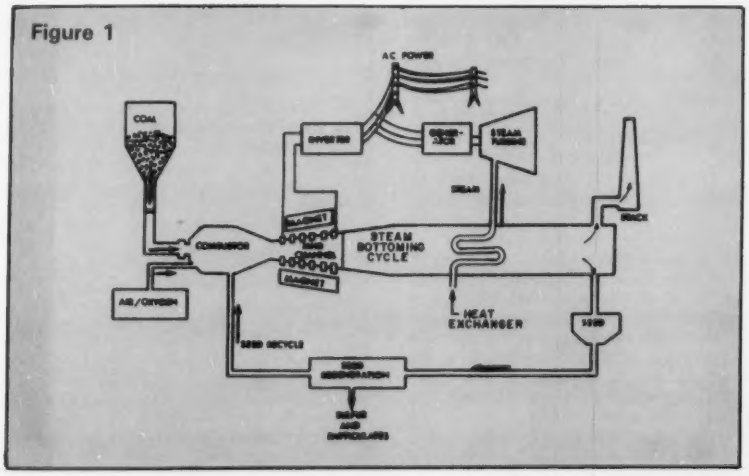
Thus, from an overall point of view, we have a conductor cutting magnetic field lines and producing an emf. From a microscopic point of view, a force is created within the fluid that acts on the moving charged particles in the fluid to separate the negatively charged electrons from the positively charged ions.

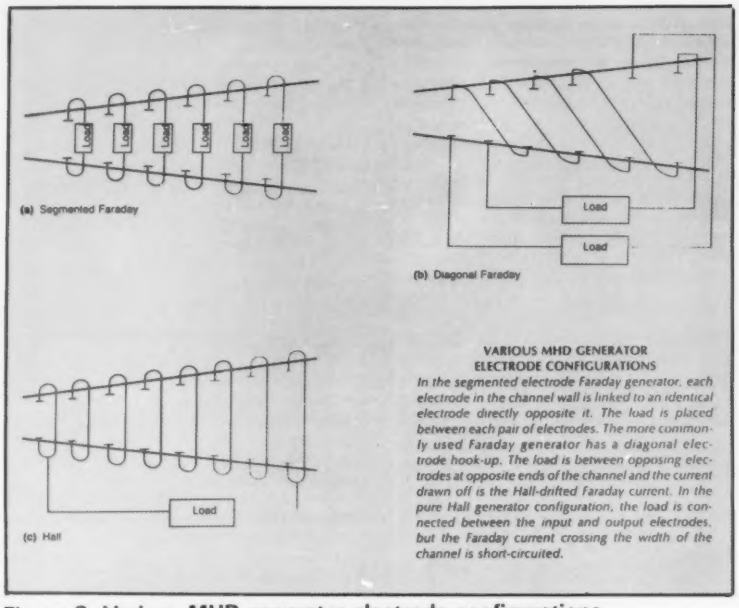
The charge separation caused by this force, called the Lorentz force (named for H. A. Lorentz), created a potential difference that can produce an electrical current when an external load is applied. The direction of the current created, known as a Faraday current, is perpendicular to both the velocity of the fluid and the external magnetic field.

A secondary effect was discovered in 1879 when Edwin H. Hall discovered that the Faraday current created an electric field around it that results in a drift force on the current. This electric field is proportional to the current density and the magnetic field and is at right angles to both the current and the magnetic field.

The Hall electric field, as it is now known, is in the same direction as the fluid flow. The Hall effect complicates design considerations for an MHD generator. Three basic MHD channel designs are currently under development. The Faraday generator draws off the Faraday current produced by the Lorentz force but does not utilize the Hall current. In order to negate the Hall current, segmented, insulated, and individually loaded electrodes are used as shown in Fig. 3(a). Each electrode pair must be individually loaded as shown. Each load will be at a different potential with respect to ground because of the Hall effect.

Figure 1





VARIOUS MHD GENERATOR ELECTRODE CONFIGURATIONS

In the segmented electrode Faraday generator, each electrode in the channel wall is linked to an identical electrode directly opposite it. The load is placed between each pair of electrodes. The more commonly used Faraday generator has a diagonal electrode hook-up. The load is between opposing electrodes at opposite ends of the channel and the current drawn off is the Hall-drifted Faraday current. In the pure Hall generator configuration, the load is connected between the input and output electrodes, but the Faraday current crossing the width of the channel is short-circuited.

Figure 3: Various MHD generator electrode configurations.

The diagonal connection scheme shown in Fig. 3(b) utilizes the Hall effect which tends to drive the current diagonally across the channel rather than straight across. A significant advantage of this scheme is that a single electrical load can be connected between the ends of the channel.

Shorting electrodes directly across the channel and connecting a load between the ends of the channel gives the Hall generator shown in Fig. 3(c). Here only the Hall current (Flowing parallel to the gas flow) is utilized. However, shorting out the Faraday current in this manner results in a significant loss of potential power.

The most attractive system configuration for commercial power generation is the MHD topping cycle with a conventional steam bottoming cycle, as shown in Fig. 1. Pulverized coal is burned in a combustor at an elevated pressure—about five times atmospheric pressure. A combustion temperature of approximately 4,500°F is required in order to obtain adequate electrical conductivity in the combustion products. Without the introduction to the combustor products of a more easily ionized material (such as potassium), the required temperature would be prohibitively high.

In order to achieve 4,500°F, it is necessary to combust coal with oxygen-enriched air or to preheat the supply air. The seed material is usually injected into the combustor to allow adequate time for mixing before the flow enters the MHD generator. The magnet strength required for MHD power generation will be in the range of four to six Tesla, with superconducting magnets required for maximum efficiency.

An Efficient System

The major advantage of MHD compared to a conventional steam cycle is its greater efficiency. The increased operating temperature is primarily responsible for this. If the gases enter the MHD generator at 4,500°F and drop some 2,000°F through the generator, the temperature level is still adequate to drive a conventional steam turbine cycle.

Conventional steam power plant efficiencies are in the 35 to 40 percent range, while a first-generation MHD plant might be 50 percent efficient, and a plant with mature technology could be up to 70 percent efficient. The improved efficiency makes better use of our coal resources and, with less heat rejected per unit of power generated, thermal pollution is reduced.

Superior from an environmental point of view, MHD's higher combustion temperature results in more nearly complete combustion—hence, greatly reduced particulate emissions, as much as 90 percent less than conventional plants. Also, the sulfur present in many coals burns to form sulfur dioxide, a serious air pollutant. The potassium seed material, supplying the needed electrical conductivity for the MHD process, serves as a scrubbing agent in the downstream steam plant. Sulfur present in the flue gas combines with potassium to form a solid, potassium sulfate (K_2SO_4), which can be removed by particulate collection equipment. In addition to sulfur removal, this process recaptures the seed from the exhaust stream so it can be reused.

Experiments carried out at the Univeristy of Tennessee Space Institute have shown that sulfur emissions can be virtually eliminated if the potassium-to-sulfur ratio is about 1.5. Figure 4 shows, from experimental results, the level of SO_2 emission from a four percent sulfur coal as a function of the potassium-to-sulfur ratio. Environmental Protection Agency (EPA) limits for a four percent sulfur coal can be met with the potassium additives (one percent by weight of total flow) required for electrical conductivity.

The MHD process also lends itself to the control of nitrogen oxide emissions. Nitric oxides (NO_x) are likely to form as the elevated temperatures associated with the MHD generator. However, their formation can be minimized by keeping the initial combustion fuel rich. Furthermore, decomposition of the NO_x that does form can be promoted by controlling the rate at which the exhaust gases are cooled. Combustion can be completed by adding air at a temperature below which NO_x will not form.

Current Research

A number of institutions are involved in the national program developing the various components to show the feasibility of MHD power generation. Thompson-Ramo-Woolridge (TRW) has recently developed and tested a 20 MW thermal slagging coal combustor and are presently developing a 50 MW combustor. AVCO Everett Research Laboratory has successfully completed a 1,000-hour electrode test under simulated coal slagging conditions, and additional hours are currently being accumulated with this hardware.

The University of Tennesses Space Institute (UTSI) is demonstrating coal burning capability with MHD and investigating the environmental aspects of the MHD steam cycle plant.

The Component Development and Integration Facility (CDIF) in Butte, Mont., is charged with the responsibility of in-

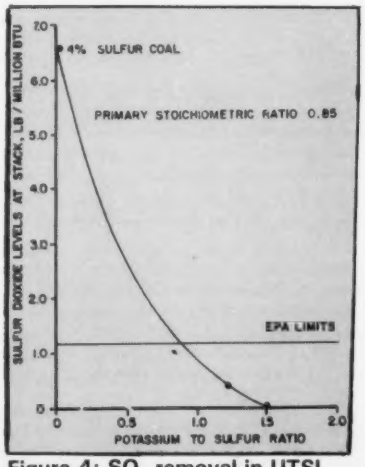


Figure 4: SO_2 removal in UTSI cell III flowtrain.

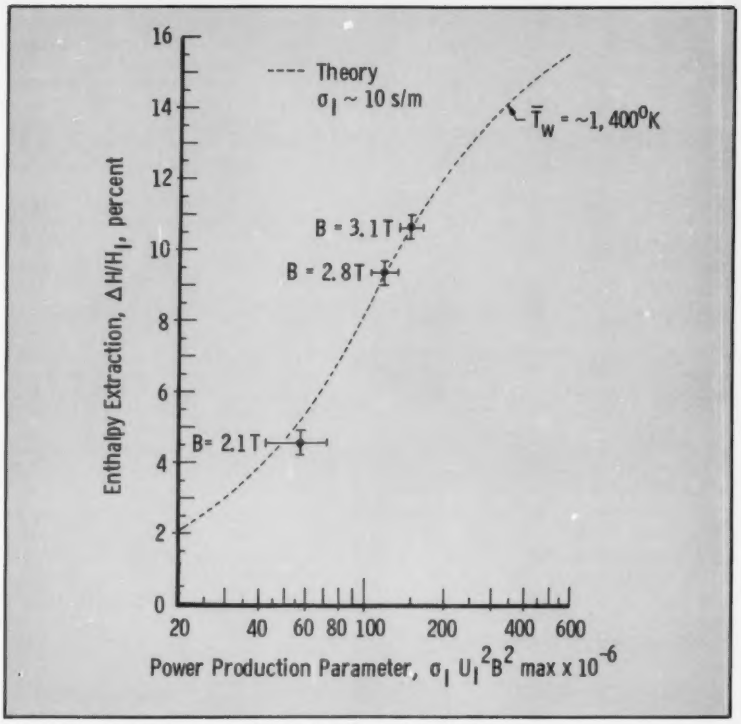

Theory
$\sigma_I \sim 10$ s/m
$\bar{T}_w = \sim 1,400^0K$
B = 3.1 T
B = 2.8 T
B = 2.1 T
Enthalpy Extraction, $\Delta H/H_I$, percent
Power Production Parameter, $\sigma_I U_I^2 B^2$ max x 10^{-6}

Figure 5: Enthalpy extraction for Faraday Mode test.

tegrating and testing the various components necessary for the complete coal burning MHD flow train, and a coal combustor and generator are currently being tested at the 1-2 MWe level.

The Arnold Engineering Development Center (AEDC), the Air Force's aerospace flight dynamics and propulsion ground test facility, is carrying out the High Performance Demonstration Experiment (HPDE).

Air Force involvement in the MHD effort through the HPDE is significant. Here, the objective is to show that a sufficiently large fraction of the energy is a combusted gas flow can be converted to electricity in an MHD generator to make is feasible for commercial power generation. The near-term goal is an enthalpy extraction of 15 percent. The progress toward this goal is depicted in Fig. 5. Three data points have been obtained to date at magnetic field levels of 2.1, 2.8, and 3.1 Tesla. The highest performance point at 3.1 Tesla resulted in 30.5 MW of electrical power produced from a 280 MW thermal input for an enthalpy extraction of 11 percent. Extrapolation of the data curve indicated the 15 percent goal can be achieved at a magnetic field strength of 5.5 Tesla, within the capability of the equipment. It is expected that this goal will be achieved in the next several months. The achievement of this goal is an important step in the MHD development program. The HPDE is a large machine with an MHD generator channel some 10 meters long and over one-half square meter in cross section—approximately 60 percent of full scale needed for commercial operation

Some indication of the state-of-the-art MHD effort, the current results that have been obtained, and the goals of the national program can be seen in Fig. 6. Shown is the 11 percent enthalpy extraction achieved at a magnetic field os 3.1 T by the AEDC HPDE. Also shown are the results of tests at AVCO, UTSI, and CDIF.

MHD and the Future

The early commercial plant (operating point shown in Fig. 5) would operate at a thermal input of some 1,000 MW. The 20 percent enthalpy extraction shown means that this plant would have an MHD contribution of some 200 MWe. The Energy Conversion Alternative Study (ECAS) operating point shown in Fig. 6 represents a large plant utilizing mature MHD technology. The total electrical output of this plant would be some 3,000 MW and the operating efficiency would approach 70 percent.

The objective of the U.S. national program is to have an early commercial type of plant on-line by the mid-1990's. The initial demonstration plant could well be a retorfit of MHD to an existing plant. An ambitious retrofit program could have a significant effect of power production in the U.S., where somewhere between 50 and 100 existing plants are suitable for retrofit. The potential is to double the output of these plants with no increase in fuel costs.

As an additional bonus, since MHD is an environmentally superior system, some oil-fired plants might be converted to coal. If MHD development continues on schedule, the goal of putting the first commercial MHD power plant on line by the mid-1990's should be achieved. E&S

(Ms. Stirling wishes to acknowledge numerous contributions by AEDC and Arvin/Calspan engineers, scientists and technicians.)

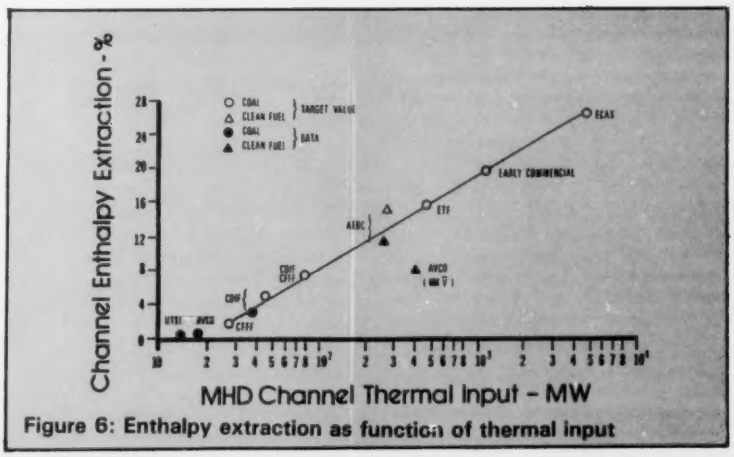
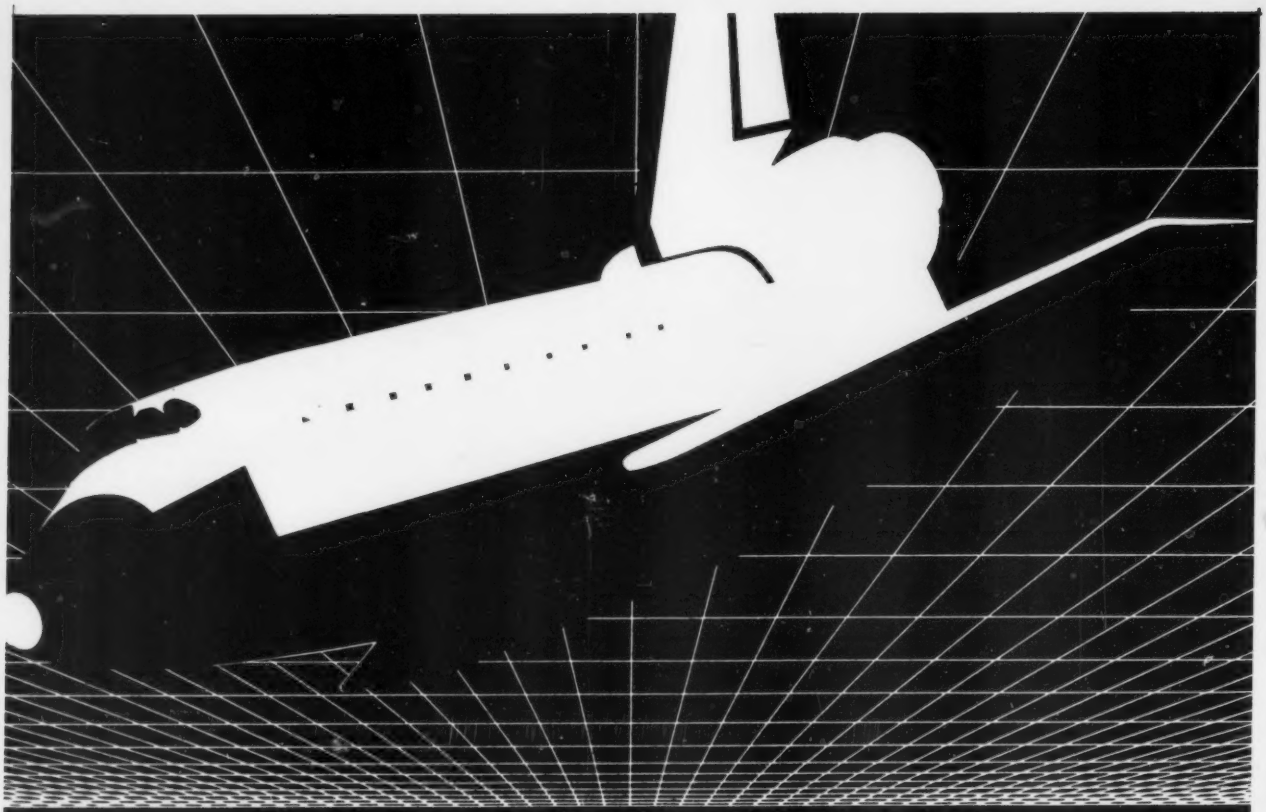


Figure 6: Enthalpy extraction as function of thermal input



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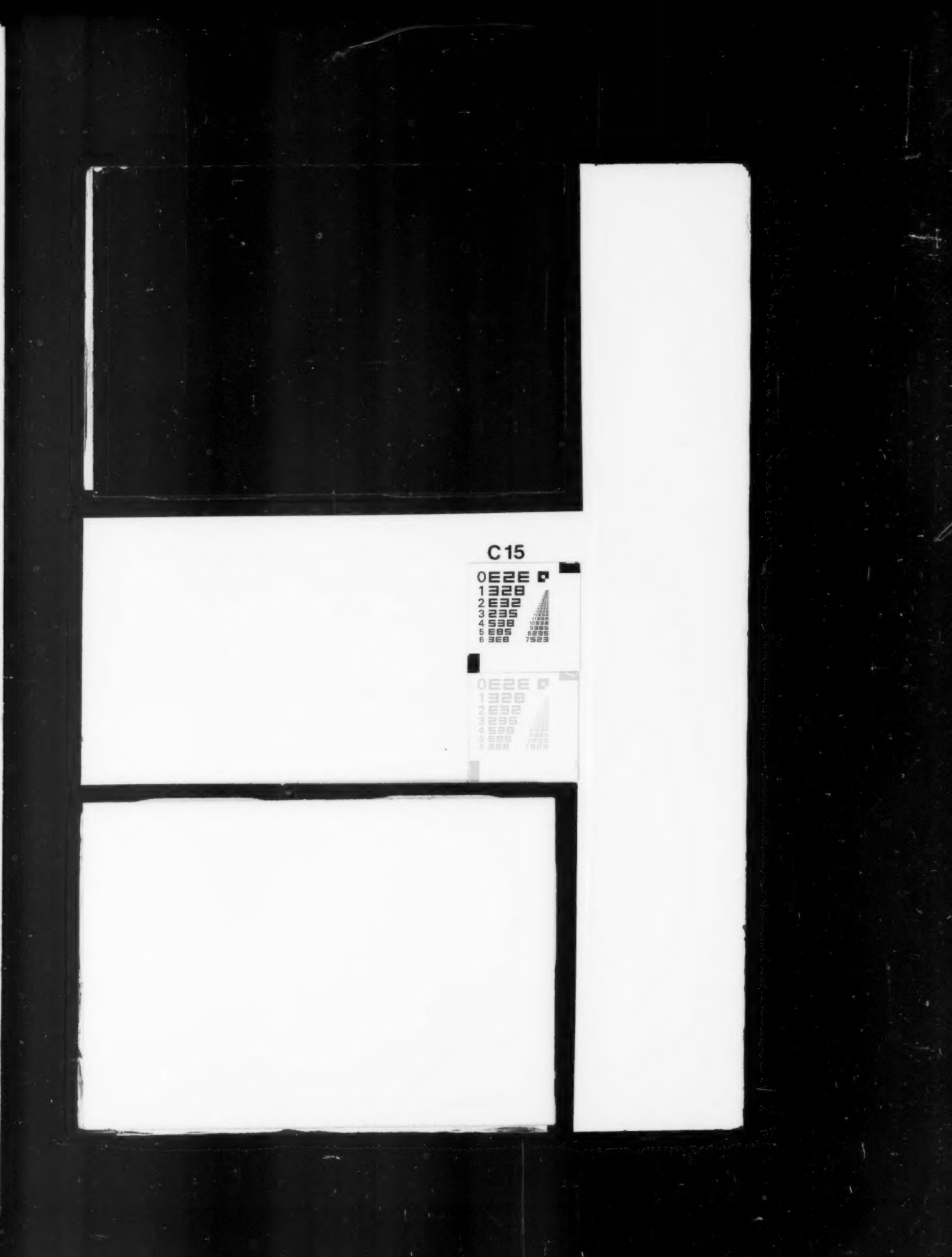
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